This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

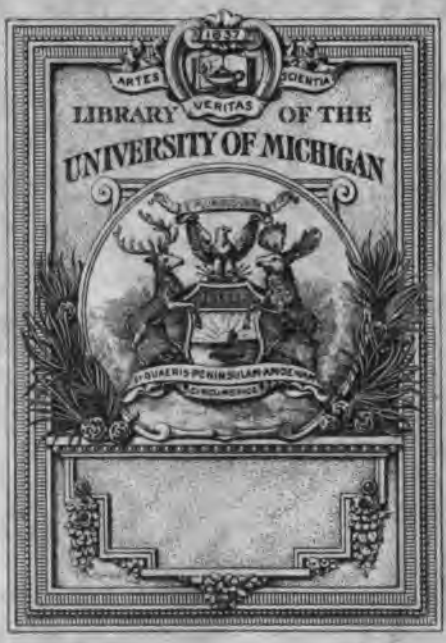
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

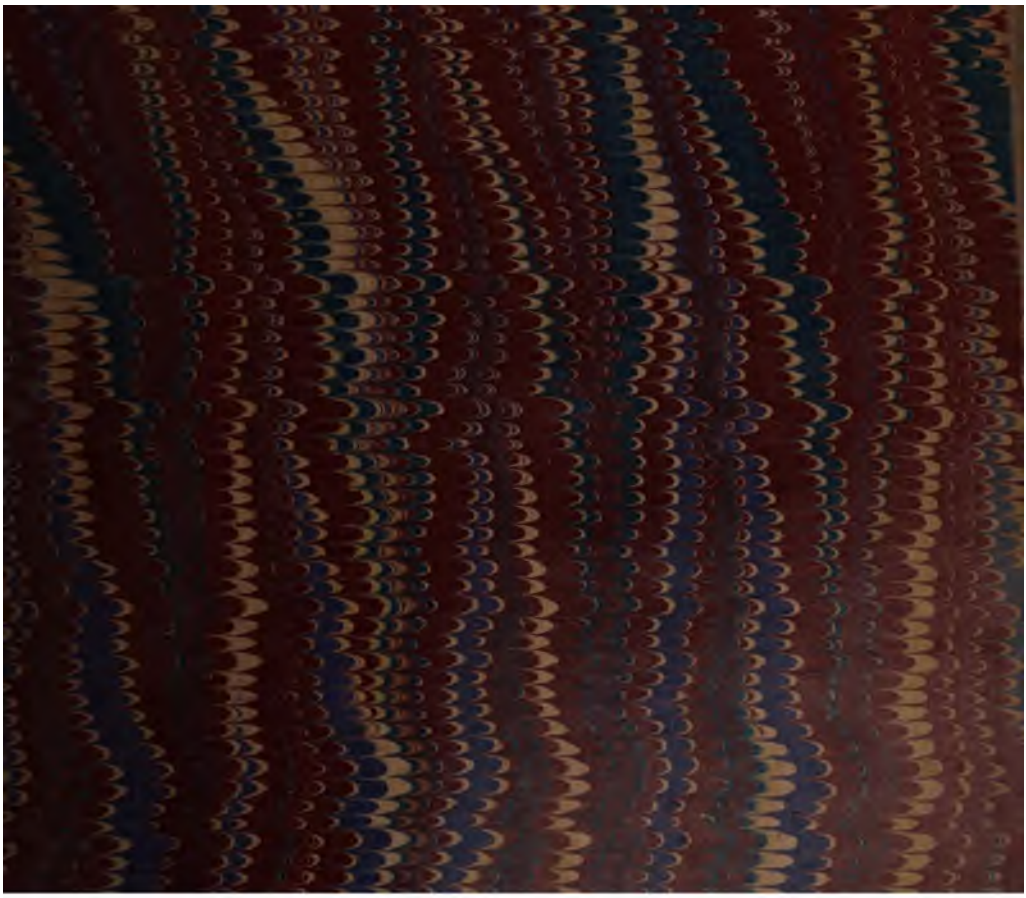
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`


ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN



UA
24
.A15

ANNUAL REPORT

OF THE

119624

SECRETARY OF WAR

FOR

THE YEAR 1893.

IN FOUR VOLUMES.

VOLUME II—IN SIX PARTS.

PART 5.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

CONTENTS.

[Alphabetical index will be found at the end of each part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS.

STATUS, changes, and distribution of officers of corps, 3; officers detached, 4.

FORTIFICATIONS.

PROJECTS and estimates, 4; appropriations and allotments: Portland Harbor, Me., Boston Harbor, Mass., 5; Narragansett Bay, R. I., New York Harbor, N. Y., 6; Philadelphia, Pa., Baltimore, Md., Washington, D. C., 8; Hampton Roads, Va., Charleston Harbor, S. C., San Francisco Harbor, Cal., 9. Sites for fortifications, 10.

PROTECTION OF SITE OF FORT NIAGARA, NEW YORK.

IN THE CHARGE OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS 11

SEA WALL AND EMBANKMENT AT DAVIDS ISLAND, NEW YORK HARBOR.

IN THE CHARGE OF LIEUT. COL. H. M. ROBERT, CORPS OF ENGINEERS..... 12

SEA WALLS AT GOVERNORS ISLAND, NEW YORK HARBOR.

IN THE CHARGE OF LIEUT. COL. H. M. ROBERT, CORPS OF ENGINEERS..... 13

WATER SUPPLY AND SEWERAGE SYSTEM AT FORT MONROE, VA.

IN THE CHARGE OF MAJ. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS..... 13

ESTIMATES OF APPROPRIATIONS FOR FORTIFICATIONS REQUIRED FOR 1894-'95

..... 14

THE BOARD OF ENGINEERS.

CONSTITUTION of Board, summary of reports rendered, 15; personal inspection made, additional duties of members, 16.

POST OF WILLETS POINT, NEW YORK—U. S. ENGINEER SCHOOL.—BATTALION OF ENGINEERS.—ENGINEER DEPOT.

OFFICER IN COMMAND, LIEUT. COL. W. R. KING, CORPS OF ENGINEERS—

Post of Willets Point, 17; U. S. Engineer School, Battalion of Engineers, Engineer Depot, 18; statement of funds, estimates, 19.

RIVER AND HARBOR IMPROVEMENTS.

GENERAL STATEMENT, removal of wrecks, 19; establishment of harbor lines, examination of bills for bridges, construction of bridges across navigable waters, bridges obstructing navigation, occupancy and injury of public works, engineer divisions, South Pass of the Mississippi River, rules and regulations for the use of canals, 20.

ATLANTIC COAST AND GULF OF MEXICO.

IN THE CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS—

St. Croix River, Me., 21; Lubec Channel, Me., Moosabec Bar, Me., 22; Narraguagus River, Me., breakwater from Mount Desert to Porcupine Island, Bar Harbor, Me., 23; Bagaduce River, Me., 24; Penobscot River, Me., 25; Belfast Harbor, Me., 26; Camden Harbor, Me., Rockland Harbor, Me., 27; Kennebec River, Me., 28; Harraseeket River, Me., Portland Harbor, Me., 30; channel in Back Cove, Portland, Me., 31; Saco River, Me., 32; Kennebunk River, Me., 33; York Harbor, Me., Bellamy River, N. H., 34; Cocheco River, N. H., 35; harbor of refuge at Little Harbor, N. H., 36; removing sunken vessels or craft obstructing or endangering navigation, examinations, 37.

IN THE CHARGE OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS—

Newburyport Harbor, Mass., 38; Merrimac River, Mass., 39; Powow River, Mass., Ipswich River, Mass., 40; Essex River, Mass., harbor of refuge, Sandy Bay, Cape Ann, Mass., 41; Gloucester Harbor, Mass., 42; Manchester Harbor, Mass., Salem Harbor, Mass., 43; Lynn Harbor, Mass., 44; Winthrop Harbor, Mass., Mystic and Malden rivers, Mass., 45; Boston Harbor, Mass., 46; Weymouth River, Mass., 47; Hingham Harbor, Mass., Scituate Harbor, Mass., 48; Plymouth Harbor, Mass., 49; Kingston Harbor, Mass., 50; Wellfleet Harbor, Mass., Provincetown Harbor, Mass., 51; Chatham Harbor, Mass., examinations, 52.

IN THE CHARGE OF CAPT. W. H. BIXBY, CORPS OF ENGINEERS—

Harbor of refuge at Hyannis, Mass., 53; harbor of refuge at Nantucket, Mass., 54; Marthas Vineyard inner harbor at Edgartown, Mass., harbor at Vineyard Haven, Mass., 55; Wareham Harbor, Mass., 56; New Bedford Harbor, Mass., 57; Westport Harbor, Mass., 58; Canapitsit Channel, Mass., Taunton River, Mass., 59; Pawtucket River, R. I., 60; Providence River and Narragansett Bay, R. I., 61; removal of Green Jacket Shoal, Providence River, R. I., 62; Greenwich Bay, R. I., cove and waterway near Coaster Harbor Island, R. I., 63; Newport Harbor, R. I., 64; harbor of refuge at Point Judith, R. I., 65; entrance to Point Judith Pond, R. I., harbor of refuge at Block Island, R. I., 66; Pawcatuck River, R. I. and Conn., 67; harbor of refuge at Stonington, Conn., 68; removing sunken vessels or craft obstructing or endangering navigation, 69; examinations, 70.

IN THE CHARGE OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS—

Mystic River, Conn., Thames River, Conn., 72; Connecticut River, Mass. and Conn., 73; harbor of refuge at Duck Island Harbor, Conn., Clinton Harbor, Conn., 76; New Haven Harbor, Conn., breakwaters at New Haven, Conn., 77; Milford Harbor, Conn., 78; Housatonic River, Conn., 79; Bridgeport Harbor, Conn., Black Rock Harbor, Conn., 80; Saugatuck River, Conn., 81; Norwalk Harbor, Conn., Wilsons Point Harbor, Conn., 82; Five Mile River Harbor, Conn., Stamford Harbor, Conn., 83; harbor at Cos Cob and Miamus River, Conn., Port Chester Harbor, N. Y., 84; Larchmont Harbor, N. Y., 85; East Chester Creek, N. Y., 86; Greenport Harbor, N. Y., Port Jefferson Harbor, N. Y., 87; Huntington Harbor, N. Y., 88; Glen Cove Harbor, N. Y., Flushing Bay, N. Y., 89; Patchogue River, N. Y., 90; Browns Creek, Sayville, N. Y., examinations, 91.

IN THE CHARGE OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS—

Hudson River, N. Y., 92; harbor at Saugerties, N. Y., 93; harbor at Rondout, N. Y., 94; Wappinger Creek, N. Y., Harlem River, N. Y., 95; East River and Hell Gate, N. Y., 97; Newtown Creek, N. Y., 99; Buttermilk Channel, New York Harbor, 100; Gowanus Bay, N. Y., Red Hook, Gowanus Creek, and Bay Ridge channels, 101; New York Harbor, N. Y., 102; Jamaica Bay, N. Y., 103; Raritan Bay, N. J., 104; removing sunken vessels or craft obstructing or endangering navigation, examinations, 105.

In the charge of Capt. Thomas L. Casey, Corps of Engineers—

Sumpawanna Inlet, N. Y., Canarsie Bay, N. Y., 106; Sheepshead Bay, N. Y., 107; Arthur Kill, N. Y. and N. J., channel between Staten Island and New Jersey, 108; Passaic River, N. J., 109; Elizabeth River, N. J., 111; Rahway River, N. J., Raritan River, N. J., 112; South River, N. J., 113; Keyport Harbor, N. J., 114; Mattawan Creek, N. J., 115; Shoal Harbor and Compton Creek, N. J., 116; Shrewsbury River, N. J., 117; Manasquan (Squan) River, N. J., examinations, 118.

In the charge of Maj. C. W. Raymond, Corps of Engineers—

Delaware River, N. J. and Pa., 119; harbor between Philadelphia, Pa., and Camden, N. J., 121; Schuylkill River, Pa., 122; ice harbor at Marcus Hook, Pa., ice harbor at head of Delaware Bay, Del., 123; construction of iron pier in Delaware Bay, near Lewes, Del., 124; Delaware Breakwater, Del., 125; Rancocas River, N. J., 126; Alloway Creek, N. J., Salem River, N. J., 127; Goshen Creek, N. J., removing sunken vessels or craft obstructing or endangering navigation, 128; examinations, 129.

In the charge of William F. Smith, United States Agent, Major of Engineers, U. S. Army, retired—

Wilmington Harbor, Del., 129; ice harbor at New Castle, Del., 130; Appoquinimink River, Del., Smyrna River, Del., 131; Murderkill River, Del., Mispillion River, Del., 132; Broadkiln River, Del., inland waterway from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 133; Susquehanna River above and below Havre de Grace, Md., 134; Northeast River, Md., Elk River, Md., 135; Fairlee Creek, Md., Chester River, Md., from Crumpton to Jones Landing, 136; Choptank River, Md., 137; La Trappe River, Md., Warwick River, Md., 138; Cambridge Harbor, Md., 139; Broad Creek River, Del., Wicomico River, Md., 140; Manokin River, Md., Onancock Harbor, Va., 141; harbor and approaches at Cape Charles City, Va., 142; removing sunken vessels or craft obstructing or endangering navigation, examinations, 143.

In the charge of Col. William P. Craighill, Corps of Engineers—

Patapsco River and channel to Baltimore, Md., 144; Channel to Curtis Bay in Patapsco River, Baltimore Harbor, Md., James River, Va., 145; removing sunken vessels or craft obstructing or endangering navigation, 147; examinations, 148.

In the charge of Maj. Charles E. L. B. Davis, Corps of Engineers—

Potomac River and Anacostia River at Washington, D. C., 148; Occoquan Creek, Va., 150; Aquia Creek, Va., 151; Lower Machodoc Creek, Va., 152; Nomini Creek, Va., 153; Patuxent River, Md., Rappahannock River, Va., 154; Urbana Creek, Va., 155; York River, Va., Mattaponi River, Va., 156; Pamunkey River, Va., 157; examinations, 158.

In the charge of Lieut. Edward Burr, Corps of Engineers—

Harbor of Norfolk and its approaches, Va., 159; approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert Point and Fort Norfolk, 160; Nansemond River, Va., 161; Chickahominy River, Va., 162; Appomattox River, Va., 163; inland water route from Norfolk, Va., to Albemarle Sound, N. C., through Currituck Sound, 164; North Landing River, Va. and N. C., 165; removing sunken vessels or craft obstructing or endangering navigation, examination, 166.

In the charge of Maj. W. S. Stanton, Corps of Engineers—

Staunton River, Va., 166; Roanoke River, N. C., 167; Pasquotank River, N. C., 168; Mackeys Creek, N. C., Ocracoke Inlet, N. C., 169; Fishing Creek, N. C., 170; Pamlico and Tar rivers, N. C., 171; Contentnia Creek, N. C., Trent River, N. C., 172; Neuse River, N. C., 173; inland waterway between Newbern and Beaufort, N. C., harbor at Beaufort, N. C., 174; inland waterway between Beaufort and New River, N. C., 175; inland waterway between New River and Swansboro, N. C., New River, N. C., 176; North East (Cape Fear) River, N. C., Black River, N. C., 177; Cape Fear River above Wilmington, N. C., 178; Cape Fear River at and below Wilmington, N. C., 179; Lockwoods Folly River, N. C., 180; Yadkin River, N. C., Georgetown Harbor, S. C., 181; Winyaw Bay, S. C., 182; removing sunken vessels or craft obstructing or endangering navigation, examinations, 183.

IN THE CHARGE OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS—

Waccamaw River, N. C. and S. C., Lumber River, N. C. and S. C., 184; Little Pedee River, S. C., Great Pedee River, S. C., Clark River, S. C., 185; Mingo Creek, S. C., Santee River, S. C., Wateree River, S. C., 186; Congaree River, S. C., Charleston Harbor, S. C., 187; Ashley River, S. C., Wappoo Cut, S. C., 188; Edisto River, S. C., Salkahatchie River, S. C., Beaufort River, S. C., removing sunken vessels or craft obstructing or endangering navigation, 189; examination, 190.

IN THE CHARGE OF CAPT. O. M. CARTER, CORPS OF ENGINEERS—

Savannah Harbor, Ga., 190; Savannah River, Ga., 191; Savannah River above Augusta, Ga., 192; Darien Harbor, Ga., Altamaha River, Ga., 193; Oconee River, Ga., 194; Ocmulgee River, Ga., 195; Brunswick Harbor, Ga., Brunswick Outer Bar, Ga., 196; Jekyl Creek, Ga., Cumberland Sound, Ga., 197; inside water route between Savannah, Ga., and Fernandina, Fla., removing sunken vessels or craft obstructing or endangering navigation, examination, 198.

IN THE CHARGE OF MAJ. JOHN C. MALLERY AND LIEUT. A. M. D'ARMIT, CORPS OF ENGINEERS—

St. Johns River, Fla., 199; Upper St. Johns River, Fla., 200; Volusia Bar, Fla., 201; Ocklawaha River, Fla., 202; St. Augustine Harbor, Fla., Indian River, Fla., 203; northwest entrance Key West Harbor, Fla., 204; Caloosahatchee River, Fla., 205; Charlotte Harbor and Pease Creek, Fla., 206; Sarasota Bay, Fla., Manatee River, Fla., 207; Tampa Bay, Fla., 208; Withlacoochee River, Fla., harbor at Cedar Keys, Fla., 209; Suwanee River, Fla., 210; examination, 211.

IN THE CHARGE OF CAPT. PHILLIP M. PRICE, CORPS OF ENGINEERS—

Apalachicola Bay, Fla., 211; Apalachicola River, the Cut-off, and Lower Chipola River, Fla., 212; Flint River, Ga., 213; Chattahoochee River, Ga. and Ala., 215; La Grange Bayou and Holmes River, Fla., 217; Choctawhatchee River, Fla. and Ala., 218; harbor at Pensacola, Fla., 219; Escambia and Conecuh rivers, Fla. and Ala., 221; Alabama River, Ala., 222; Tallapoosa River, Ala., 223; Coosa River, Ga. and Ala., 224; operating and care of canals and other works of navigation on Coosa River, Ga. and Ala., Cahaba River, Ala., 226; examinations, 228.

IN THE CHARGE OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS—

Mobile Harbor, Ala., 228; Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, 229; Warrior and Tombigbee rivers, Ala. and Miss., 230; Noxubee River, Miss., Pascagoula River, Miss., 232; Chickasahay River, Miss., 233; Bluff Creek, Miss., Leaf River, Miss., harbor at Biloxi, Miss., 234; Pearl River below Jackson, Miss., Pearl River between Carthage and Jackson, Miss., 235; Pearl River between Edinburg and Carthage, Miss., 236; Bogue Chitto, La., removing sunken vessels or craft obstructing or endangering navigation, examinations, 237.

IN THE CHARGE OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS—

Inspection of the improvement of the South Pass of the Mississippi River, 238; Chefuncte River and Bogue Falia, La., 239; Tickfaw River and its tributaries, La., 240; Amite River and Bayou Manchac, La., 241; Bayou Lafourche, La., 242; Bayou Terrebone, La., Bayou Plaquemine, Grand River, and Pigeon Bayou, La., 243; Bayou Courtableau, La., 244; Bayou Teche, La., connecting Bayou Teche with Grand Lake at Charenton, La., 245; channel, bay, and passes of Bayou Vermillion, La., Mermentau River and tributaries, La., 246; mouth of passes of Calcasieu River, La., 247; harbor at Sabine Pass, Tex., 248; Sabine River, Tex., 249; Neches River, Tex., removing sunken vessels or craft obstructing or endangering navigation, 250; examinations, 251.

IN THE CHARGE OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS—

Securing mouth of Bayou Plaquemine, La., from further caving, 252.

IN THE CHARGE OF MAJ. A. M. MILLER, CORPS OF ENGINEERS—

Entrance to Galveston Harbor, Tex., 252; ship channel in Galveston Bay, Tex., 253; channel in West Galveston Bay, Tex., 254; Trinity River, Tex., 255; Cedar Bayou, Tex., Buffalo Bayou, Tex., 256; harbor at Brazos Santiago, Tex., examination, 257.

WESTERN RIVERS.

In the charge of Capt. J. H. Willard, Corps of Engineers—

Red River, La. and Ark., 258; Red River above Fulton, Ark., 260; Ouachita and Black rivers, Ark. and La., Bayous D'Arbonne and Corney, La., 261; Bayou Bartholomew, La. and Ark., 262; Bœuf River, La., Tensas River and Bayou Maçon, La., 263; Big Black River, Miss., Yazoo River, Miss., 264; mouth of Yazoo River, Miss., 265; Tchula Lake, Miss., Tallahatchee River, Miss., 266; Steele and Washington bayous, Miss., 267; Big Sunflower River, Miss., 268; Big Hatchee River, Tenn., Forked Deer River, Tenn., water gauges on Mississippi River and its principal tributaries, 269; survey of Cypress Bayou and the lakes between Jefferson, Tex. and Shreveport, La., examinations, 271.

In the charge of Capt. H. S. Taber, Corps of Engineers—

Removing obstructions in Arkansas River, improving Arkansas River, 272; Fourche Le Fevre River, Ark., 274; Petit Jean River, Ark., White River, Ark., 275; Cache River, Ark., Little Red River, Ark., 276; Black River, Ark. and Mo., Black River, Mo., 277; St. Francis River, Ark., St. Francis River, Mo., 278; Little River, Mo., removing sunken vessels or craft obstructing or endangering navigation, examinations, 279.

In the charge of Capt. S. W. Roessler, Corps of Engineers—

Examinations of Memphis Harbor and Wolf River, Tenn., 280.

In the charge Maj. Charles J. Allen, Corps of Engineers—

Removing snags and wrecks from Mississippi River, 280; Mississippi River between Ohio and Missouri rivers, 281; harbor at St. Louis, Mo., 282; Gasconade River, Mo., Osage River, Mo., 283; Kaskaskia River, Ill., 284.

In the charge of Maj. A. Mackenzie, Corps of Engineers—

Operating snag boats and dredge boats on Upper Mississippi River, improving Mississippi River between Missouri River and Minneapolis, 285; Des Moines Rapids, Mississippi River, 286; operating and care of Des Moines Rapids Canal and Dry Dock, examinations, 287.

In the charge of Maj. W. A. Jones, Corps of Engineers—

Mississippi River above Falls of St. Anthony, Minn., 288; reservoirs at headwaters of Mississippi River, 289; Chippewa River, including Yellow Banks, Wis., 290; St. Croix River, Wis. and Minn., 291; Minnesota River, Minn., 292; Red River of the North, Minn. and N. Dak., 293; gauging Mississippi River at or near St. Paul, Minn., 294.

In the Charge of Lieut. Col. Chas. R. Suter, Corps of Engineers—

Examination of Kansas River, Kans., 294.

In the charge of Capt. Harry F. Hodges, Corps of Engineers—

Missouri River between the Great Falls, Mont., and Sioux City, Iowa, 295; removal of snags and other obstructions in Missouri River above Sioux City, Iowa, 296; examination of Missouri River between Three Forks and Canyon Ferry, Mont., Yellowstone River, Mont. and N. Dak., examination, 297.

In the charge of Capt. John Biddle, Corps of Engineers—

Obion River, Tenn., Tennessee River above Chattanooga, Tenn., 298; Tennessee River below Bee Tree Shoals, Ala., 300; Hiwassee River, Tenn., French Broad River, Tenn., 301; Little Pigeon River, Tenn., 302; Clinch River, Tenn., 303; Cumberland River below Nashville, Tenn., 304; Cumberland River above Nashville, Tenn., 305; Cumberland River above mouth of the Jellico, Ky., Caney Fork River, Tenn., 306; examinations, 307.

In the Charge of Capt. George W. Goethals, Corps of Engineers—

Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala., 308; operating and care of Muscle Shoals Canal, Tennessee River, 310.

In the charge of Lieut. Col. Amos Stickney, Corps of Engineers—

Ohio River, 310; operating snag boat on Ohio River, operating and care of Davis Island Dam, Ohio River, Pa., 312; movable dam in Ohio River below mouth of Beaver River, Pa., Monongahela River, W. Va. and Pa., 313; operating and care of Locks and Dams Nos. 8 and 9, Monongahela River, purchase of Lock and Dam No. 7, Monongahela River, purchase of Lock and Dam No. 6, Monongahela River, 314; Cheat River, W. Va., Allegheny River, Pa., 315; dam at Herr Island, Allegheny River, Pa., ice harbor at mouth of Muskingum River, Ohio, 316; Muskingum River, Ohio, operating and care of locks and dams on Muskingum River, Ohio, 317; examinations, 318.

In the charge of Lieut. Col. G. J. Lydecker, Corps of Engineers—

Falls of the Ohio River, at Louisville, Ky., 320; Indiana Chute, Falls of the Ohio River, 321; operating and care of Louisville and Portland Canal, Ky., Wabash River, Ind., and Ill. 322; White River, Ind., 323; examinations, 324.

In the charge of Col. William P. Craighill, Corps of Engineers—

Great Kanawha River, W. Va., 324; operating and care of locks and dams on Great Kanawha River, W. Va., Elk River, W. Va., 326; Gauley River, W. Va., 327; New River, Va. and W. Va., 328.

In the charge of Maj. D. W. Lockwood, Corps of Engineers—

Tradewater River, Ky., Lock No. 2, Green River, at Rumsey, Ky., Green River above mouth of Big Barren River, Ky., 329; operating and care of locks and dams on Green and Barren rivers, Ky., Rough River, Ky., 330; Kentucky River, Ky., 331; operating and care of locks and dams on Kentucky River, Ky., Licking River, Ky., between Farmers and West Liberty, Big Sandy River, W. Va. and Ky., 332; Levisa Fork of Big Sandy River, Ky., Tug Fork of Big Sandy River, W. Va. and Ky., 333; Guyandotte River, W. Va., Little Kanawha River, W. Va., 334; operating and care of lock and dam on Little Kanawha River, W. Va., Buckhannon River, W. Va., examinations, 335.

LAKE HARBORS AND RIVERS.

In the charge of Maj. Clinton B. Sears, Corps of Engineers—

Harbor at Grand Marais, Minn., harbor at Agate Bay, Minn., 336; harbor at Duluth, Minn., 337; harbor at Superior Bay and St. Louis Bay, Wis., 338; Minnesota Point, at Superior, Wis., 339; harbor at Ashland, Wis., harbor at Ontonagon, Mich., 340; Eagle Harbor, Mich., waterway from Keweenaw Bay to Lake Superior, via Portage Lake and River, Mich., 341; operating and care of waterway from Keweenaw Bay to Lake Superior, via Portage Lake and River, Mich., harbor at Marquette, Mich., 342; harbor of refuge at Grand Marais, Mich., 343; examination, 344.

In the charge of Maj. James F. Gregory, Corps of Engineers—

Manistique Harbor, Mich., 344; Cedar River Harbor, Mich., Menominee Harbor, Mich. and Wis., 345; Menominee River, Mich. and Wis., Oconto Harbor, Wis., 346; Pensaukee Harbor, Wis., Green Bay Harbor, Wis., 347; Sturgeon Bay and Lake Michigan Canal, Wis., 348; operating and care of Sturgeon Bay and Lake Michigan Canal, Wis., harbor of refuge at eastern entrance of Sturgeon Bay and Lake Michigan Canal, Wis., 349; Ahnapee Harbor, Wis., Kewaunee Harbor, Wis., 350; Two Rivers Harbor, Wis., 351; Manitowoc Harbor, Wis., Sheboygan Harbor, Wis., 352; Port Washington Harbor, Wis., harbor of refuge at Milwaukee Bay, Wis., 353; Milwaukee Harbor, Wis., 354; Racine Harbor, Wis., Kenosha Harbor, Wis., 355; Waukegan Harbor, Ill., 356; Fox River, Wis., 357; operating and care of locks and dams on Fox River, Wis., removing sunken vessels or craft obstructing or endangering navigation, 358; examinations, 359.

In the charge of Capt. W. L. Marshall, Corps of Engineers—

Chicago Harbor, Ill., 359; Calumet Harbor, Ill., Calumet River, Ill. and Ind., 361; Illinois River, Ill., 362; operating and care of La Grange Lock and Dam, Illinois River, Ill., Illinois and Mississippi Canal, Ill., 364; examinations, 365.

In the charge of Maj. William Ludlow, Corps of Engineers—

Michigan City Harbor, Ind., 366; St. Joseph Harbor, Mich., 368; St. Joseph River, Mich., 369; South Haven Harbor, Mich., Saugatuck Harbor, Mich., 370; Holland (Black Lake) Harbor, Mich., 371; Grand Haven Harbor, Mich., 372; Muskegon Harbor, Mich., 373; White Lake Harbor, Mich., 374; Pentwater Harbor, Mich., Ludington Harbor, Mich., 375; Manistee Harbor, Mich., 376; harbor of refuge at Portage Lake, Manistee County, Mich., 377; Frankfort Harbor, Mich., Charlevoix Harbor and entrance to Pine Lake, Mich., 378; Petoskey Harbor, Mich., 379; Cheboygan Harbor, Mich., 380; Thunder Bay Harbor, Mich., Alpena Harbor (Thunder Bay River), Mich., 381; Saginaw River, Mich., 382; harbor of refuge at Sand Beach, Lake Huron, Mich., 384; Black River at Port Huron, Mich., 385; mouth of Black River, Mich., Clinton River, Mich., 386; Rouge River, Mich., 387; turning basin in Rouge River, Mich., examinations, 388.

In the charge of Col. O. M. Poe, Corps of Engineers—

Ship channel connecting the waters of the Great Lakes between Chicago, Duluth, and Buffalo, 389; operating and care of St. Marys Falls Canal, Mich., St. Marys River at the Falls, Mich., 390; Hay Lake Channel, St. Marys River, Mich., 391; St. Clair Flats Canal, Mich., 392; operating and care of St. Clair Flats Canal, Mich., Grossepoint Channel, Mich., Detroit River, Mich., 393; investigation of raft towing on the Great Lakes, 394.

In the charge of Lieut. Col. Jared A. Smith, Corps of Engineers—

Monroe Harbor, Mich., Toledo Harbor, Ohio, 395; Port Clinton Harbor, Ohio, 396; Sandusky Harbor, Ohio, 397; Sandusky River, Ohio, Huron Harbor, Ohio, 398; Vermilion Harbor, Ohio, 399; Black River Harbor, Ohio, Cleveland Harbor, Ohio, 400; Fairport Harbor, Ohio, 401; Ashtabula Harbor, Ohio, 402; Conneaut Harbor, Ohio, 403; removing sunken vessels or craft obstructing or endangering navigation, 404.

In the charge of Maj. E. H. Ruffner, Corps of Engineers—

Erie Harbor, Pa., 404; Presque Isle Peninsula, Erie Harbor, Pa., Dunkirk Harbor, N. Y., 405; Buffalo Harbor, N. Y., 406; Tonawanda Harbor and Niagara River, N. Y., Niagara River from Tonawanda to Port Day (Niagara Falls), N. Y., 407; Wilson Harbor, N. Y., Olcott Harbor, N. Y., Oak Orchard Harbor, N. Y., 408; examination, 409.

In the charge of Capt. Dan C. Kingman, Corps of Engineers—

Charlotte Harbor, N. Y., 409; Pultneyville Harbor, N. Y., 410; harbor at Great Sodus Bay, N. Y., 411; harbar at Little Sodus Bay, N. Y., Oswego Harbor, N. Y., 412; harbor at Sacketts Harbor, N. Y., examination, 414.

In the charge of Capt. Smith S. Leach, Corps of Engineers—

Shoals between Sister Islands and Cross-over Light, St. Lawrence River, N. Y., Ogdensburg Harbor, N. Y., 415; breakwater at Rouse Point, Lake Champlain, N. Y., Great Chazy River, N. Y., 416; Plattsburg Harbor, N. Y., Burlington Harbor, Vt., Otter Creek, Vt., 417; Ticonderoga River, N. Y., narrows of Lake Champlain, N. Y. and Vt., 418; breakwater construction in Lake Champlain, examinations, 419.

PACIFIC COAST.

In the charge of Col. G. H. Mendell, Corps of Engineers—

Oakland Harbor, Cal., 419; examination, 420.

In the charge of Lieut. Col. W. H. H. Benyaurd, Corps of Engineers—

Napa River, Cal., Redwood Creek, Cal., 421; San Luis Obispo Harbor, Cal., 422; Wilmington Harbor, Cal., 423; San Diego Harbor, Cal., Colorado and Gila rivers at Yuma, Ariz., 424; examinations, 425.

IN THE CHARGE OF MAJ. W. H. HEUER, CORPS OF ENGINEERS—

San Joaquin River, Cal., 426; Mokelumne River, Cal., 427; Sacramento and Feather rivers, Cal., 428; Petaluma Creek, Cal., Humboldt Harbor and Bay, Cal., 429; examinations, 431.

IN THE CHARGE OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS—

Coquille River, Oregon, 432; Coquille River, Oregon, between Coquille City and Myrtle Point, 433; entrance to Coos Bay and Harbor, Oregon, 434; Umpqua River, Oregon, mouth of Siuslaw River, Oregon, 435; Yaquina Bay, Oregon, 436; Tillamook Bay and Bar, Oregon, entrance to Nehalem Bay, Oregon, 437; Upper Snake River, Idaho, between Huntington Bridge and Seven Devils mining district, Upper Columbia and Snake rivers, Oregon and Wash., 438; Columbia River, between head of Rock Island Rapids and foot of Priest Rapids, Wash., 439; survey of Columbia River from the international boundary line to Rock Island Rapids, Wash., 440; Nasel River, Wash., Willapa River and Harbor, Wash., 441; Grays Harbor and Chehalis River, Wash., Chehalis River, Wash., 442; Harbor at Olympia, Wash., Swinomish Slough, Wash., 443; Puget Sound and its tributary waters, Wash., examinations, 444.

IN THE CHARGE OF MAJ. THOS. H. HANDBURY, CORPS OF ENGINEERS—

Mouth of Columbia River, Oregon and Wash., 447; Columbia River, between Vancouver, Wash., and mouth of Willamette River, 449; canal at the Cascades, Columbia River, Oregon, 450; Columbia and Lower Willamette rivers below Portland, Oregon, 452; Willamette River above Portland, Oregon, 455; Cowlitz River, Wash., Youngs and Klaskuine rivers, Oregon, 456; gauging waters of Columbia, River, Oregon and Wash., examinations, 457.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS 459

SUPERVISION OF THE HARBOR OF NEW YORK 459

MISSISSIPPI RIVER COMMISSION 459

MISSOURI RIVER COMMISSION 460

CALIFORNIA DÉBRIS COMMISSION 460

HARBOR LINES 461

Shaws Cove, New London Harbor, Conn., Bridgeport Harbor, Conn., New York Harbor and its adjacent waters, 461; Savannah River in vicinity of quarantine station near Fort Pulaski, Savannah, Ga., Allouez Bay, near Superior, Wis., Oconto Harbor, Wis., Milwaukee River, Milwaukee, Wis., Black River at Port Huron, Mich., St. Marys River at Sault Ste. Marie, Mich., Detroit, Mich., Oswego, N. Y., ports in the State of Washington, 462; Columbia River (Youngs Bay) at Flavel, Oregon, 463.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

(1) Bridge of Marietta and North Georgia Railway Company across Tennessee River at Knoxville, Tenn., 463; (2) bridge of the St. Paul, Minneapolis and Manitoba Railway Company across Columbia River, Washington, (3) bridge of the Chesapeake and Ohio Railroad Company across Big Sandy River at Catlettsburg, Ky., (4) bridge of the Newport and Cincinnati Bridge Company across Ohio River at Cincinnati, (5) bridge of the West Elizabeth Bridge Company across Monongahela River at Elizabeth, Pa., (6) bridge of the Florida Central and Peninsular Railroad Company across St. Marys River, Georgia, and Florida, 464; (7) bridge of the Southern Bridge and Railway Company across Mississippi River above New Orleans, La., (8) bridge of the Occidental Bridge and Construction Company across Missouri River at St. Charles, Mo., (9) bridge of the Omaha Bridge and Terminal Railway Company across Missouri River between Council Bluffs, Iowa, and East Omaha, Nebr., (10) bridge of the Litchfield, Carollton and Western Railroad Company across Illinois River at Columbiana, Ill., (11) bridge of the Homestead and Pittsburgh Bridge Company across Monongahela River between Pittsburg and Homestead, Pa., (12) bridge of the Natchitoches Cane River Bridge Company across Cane River at

Natchitoches, La., (13) trestle and bridges of the Mobile and Dauphin Island Railroad and Harbor Company from Cedar Point to Dauphin Island, Alabama, across the shoal water between Mobile Bay and Mississippi Sound, 465; (14) bridge of the Youghiogheny Central Railway Company across Youghiogheny River in Fayette County, Pa., (15) bridge of the State Line Railroad Company across Cheat River at Point Marion, Pa., (16) bridge of Stanislaus County, Cal., across San Joaquin River near Grayson, (17) bridge of the Philadelphia Belt Line Railroad Company across Frankford Creek, Philadelphia, Pa., (18) bridge of the North Galveston, Houston and Kansas City Railroad Company across Dickinson Bayou, Texas, (19) bridge of the city of Kewaunee, Wis., across Kewaunee River at Park Street, (20) bridge of the Pennsylvania Railroad Company across Hackensack River, New Jersey, (21) bridge of the Lake Shore and Michigan Southern Railway Company across Sandusky Bay, Ohio, (22) bridge of the Missouri, Kansas and Texas Railway Company of Texas across White Oak Bayou at Houston, Tex., 466; (23) bridge of the Chesapeake and Ohio Railway Company across Gauley River, West Virginia, (24) bridge of San Joaquin County, Cal., across San Joaquin River at Garwood Ferry crossing, (25) bridge of Glenn County, Cal., across Sacramento River at Butte City, (26) bridge of the city of Chicago, Ill., across south branch of Chicago River at South Halsted Street, (27) bridge of the Wilmington, Columbia and Augusta Railroad Company across Lumber River, North Carolina, (28) bridges of the Boston and Maine Railroad Company across Charles River in Boston and Cambridge, Mass., (29) bridge of the city of New York across Harlem River, New York, at Broadway crossing, (30) bridge of the Chicago and Northern Pacific Railroad Company across west fork of south branch of Chicago River, in Chicago, Ill., (31) bridges of the East River Bridge Company across East River, New York, between New York and Brooklyn, 467; (32) bridge of the Wabash Railroad Company across Rouge River near Detroit, Mich., (33) bridges of the Florida Central and Peninsular Railroad Company on the line of its Savannah extension across Ogeechee, Altamaha, and Satilla rivers, Georgia, (34) bridge of Whatcom County, Wash., across Nooksack River at Ferndale, (35) bridge of the city of North Muskegon, Mich., across Muskegon Lake, (36) bridge of the city of Muskegon, Mich., across Muskegon River, 468; (37) bridges of the city of New York across Harlem River at Third avenue, (38) bridge of San Joaquin County, Cal., across south fork of Mokelumne River at New Hope Landing, (39) bridge of the Long Island Railroad Company across Dutch Kills Creek at Long Island City, N. Y., (40) temporary bridge of the Lynn and Boston Railroad Company across Mystic River at Boston, Mass., (41) bridge of the city of Milwaukee, Wis., across Milwaukee River, (42) bridge of the Mount Pleasant and Seaview City Railroad Company across cove at Sullivans Island, Charleston Harbor, South Carolina, (43) bridge of the Louisville, St. Louis and Texas Railway Company across Salt River near West Point, Ky., (44) bridge of the Harlem River and Portchester Railroad Company across Bronx River below West Farms, N. Y., (45) bridge of the Jacksonville, Tampa and Key West Railway Company across St. Johns River at foot of Lake Monroe, Florida, 469; (46) bridge of the Labadieville Bridge Company across Bayou Lafourche at Labadieville, La., (47) bridge of the Napoleonville Bridge Stock Company across Bayou Lafourche at Napoleonville, La., (48) bridge of the Manchester and Augusta Railroad Company across Santee River, about 17 miles below mouth of Congaree River, Georgia, (49) bridge of Orange County, Tex., across Cow Bayou, about 6 miles above its confluence with Sabine River, (50) bridge of the Tarentum Bridge Company across Alleghany River at New Kensington, Pa., (51) bridge of the city of Boston, Mass., across Fort Point Channel at Dover street, (52) bridge of the city of Milwaukee, Wis., across North Menomonee Canal at Sixteenth street, (53) bridge of the city of Milwaukee, Wis., across Kinnickinnic River at Clinton street, (54) bridge of Knox County, Tenn., across Holston River near Boyds Ferry, near Knoxville, (55) bridge of the Jacksonville, Tampa and Key West Railway Company across McGirts Creek, Duval County, Fla., (56) bridge of the Jacksonville, Tampa and Key West Railway Company across Black Creek, Clay County, Fla., 470; (57) bridge of the Jacksonville, St. Augustine and Indian River Railway Company across St. Lucie River, Florida, (58) bridge of the Jacksonville, St. Augustine and Indian River Railway Company across Jupiter River, Florida, (59) bridge of the Louisville and Nashville Railroad Company across Kentucky River at Frankfort, Ky., (60) bridge of the Chicago and West Michigan Railway Company across St. Joseph River, Michigan, near its mouth, 471; (61) bridge of the Pittsburg, Fort Wayne and Chicago Railroad Company across south branch of Chicago River near Nineteenth street, Chicago, Ill., (62) bridge of Cumberland County, Me., across mouth of Fore River, Portland Harbor, (63) bridge of the Nashville, Chattanooga and St. Louis Railway Company across Tennessee River at Johnsonville, Tenn., 472: (64) bridge of Mobile County, Ala., across Three Mile Creek, (65) bridge of the city of Frankfort and county of Franklin, Ky., across Kentucky River, 473.

BRIDGES OBSTRUCTING NAVIGATION.

(1) Bridge across Buffalo Bayou, near Houston, Tex., (2) bridge across Dickinson Bayou, Texas, 473; (3) bridge across Fore River, Portland Harbor, Maine, (4) bridge across Housatonic River, between Stratford and Milford, Conn., (5) bridge across Sakonnet River at Tiverton, R. I., 474.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.....475

MISCELLANEOUS.

WASHINGTON AQUEDUCT.

IN THE CHARGE OF COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS—

Washington Aqueduct, 475; increasing the water supply of Washington, D. C., 478; erection of fish ways at Great Falls, 479.

PUBLIC BUILDINGS AND GROUNDS AND WASHINGTON MONUMENT, DISTRICT OF COLUMBIA.

IN THE CHARGE OF COL. JOHN M. WILSON, LIEUT. COL., CORPS OF ENGINEERS..... 480

NORTHERN AND NORTHWESTERN LAKES.

SURVEYS, 481; correcting engraved plates, printing and issuing of charts, 483. Surveys: St. Marys River from White Fish Bay to Detour light-house, Seneca Shoal, Lake Erie, discharges of Niagara River, resurvey of the lake front at Chicago, shoal at the mouth of the Niagara River, 484; St. Lawrence River, 485. Estimates, water levels, 486.

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN YELLOWSTONE NATIONAL PARK.

IN THE CHARGE OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS..... 486

MILITARY AND OTHER MAPS..... 488

RECONNAISSANCES AND EXPLORATIONS.

OFFICERS on duty at headquarters of military departments, operations in Department of the Missouri, 488; operations in Department of the Columbia, Department of the Platte, Department of California, 489.

ESTIMATES FOR AMOUNTS REQUIRED FOR SURVEYS AND RECONNAISSANCES IN MILITARY DEPARTMENTS, AND FOR MAPS, INCLUSIVE OF WAR MAPS..... 489

OFFICE OF THE CHIEF OF ENGINEERS.

OFFICERS in charge of divisions, 490.

STATEMENT SHOWING RANK AND DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR ENDING JUNE 30, 1893.. 491

LAWS AFFECTING THE CORPS OF ENGINEERS, FIFTY-SECOND CONGRESS, SECOND SESSION, 1892–'93.....519

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

CONSTRUCTION of gun and mortar batteries, New York Harbor, 600; gun-lift battery No. 1, 607; construction of torpedo shed, New York Harbor, 617.

APPENDIX No. 2.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

CONSTRUCTION of gun and mortar batteries, San Francisco Harbor, Cal., 619; mortar battery No. 1, 622.

APPENDIX No. 3.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

CONSTRUCTION of mining casemate, San Francisco Harbor, Cal., 623.

APPENDIX No. 4.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

PROTECTION of the site of Fort Niagara, N. Y., 625.

APPENDIX No. 5.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Sea wall and embankment at Davids Island, New York Harbor, 629; sea walls on Governors Island, New York Harbor, 631.

APPENDIX No. 6.

REPORT OF MAJOR CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Water supply at Fort Monroe, Va., 635; sewerage system at Fort Monroe, Va., 642.

APPENDIX NO. 7.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

POST of Willets Point, New York Harbor, 647; United States Engineer School, Battalion of Engineers, 649; Engineer depot, 654; experiments, 656; statement of funds, 657; new appropriations, estimates, 659. Appendixes: (A) programme of study and instruction for summer season, May–November, 1892, 660; (B) programme of study and instruction for winter season, December, 1892, to May, 1893, 662; (C) programme of study and instructions for summer season, June–November, 1893, 665.

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Croix River, Me., 670; Lubec Channel, Me., 671; Moosabec Bar, Me., 673; Narraguagus River, Me., 674; breakwater from Mount Desert to Porcupine Island, Bar Harbor, Me., 676; Bagaduce River, Me., 681; Penobscot River, Me., 682; Belfast Harbor, Me., 687; Camden Harbor, Me., 689; Rockland Harbor, Me., 691; Kennebec River, Me., 693; Harraseeket River, Me., 699; Portland Harbor, Me., 701; Channel in Back Cove, Portland, Me., 705; Saco River, Me., 708; Kennebunk River, Me., 712; York Harbor, Me., 714; Bellamy River, N. H., 716; Cocheco River, N. H., 717; harbor of refuge at Little Harbor, N. H., 719; removing sunken vessels or craft obstructing or endangering navigation, 722.

EXAMINATIONS.—Channel near Hardys Point, below Pembroke, Me., 722; South Fork of Bagaduce River, Me., 724; Vinal Haven, or Carver Harbor, Me., 725; Lincolnville (Duck Trap) Harbor, Me., 727; Frenchs Beach Harbor, Me., 728; Rockland Harbor, Me., 729; Owls Head Harbor, Me., 730; Tenant Harbor, Me., 732; Georges River, Me., 734; channel on south side of Portland Harbor, Me., 735.

APPENDIX B.

REPORT OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Newburyport Harbor, Mass., 739; Merrimac River, Mass., 742; Powow River, Mass., 745; Ipswich River, Mass., 746; Essex River, Mass., 747; harbor of refuge, Sandy Bay, Cape Ann, Mass., 748; Gloucester Harbor, Mass., 751; Manchester Harbor, Mass., 754; Salem Harbor, Mass., 756; Lynn Harbor, Mass., 758; Winthrop Harbor, Mass., 761; Mystic and Malden rivers, Mass., 762; Boston Harbor, Mass., 763; Weymouth River, Mass., 773; Hingham Harbor, Mass., 774; Scituate Harbor, Mass., 776; Plymouth Harbor, Mass., 778; Kingston Harbor, Mass., 781; Wellfleet Harbor, Mass., 782; Provincetown Harbor, Mass., 784; Chatham Harbor, Mass., 786.

EXAMINATIONS.—Gloucester Harbor, Mass., 787; Vincent Cove, Gloucester Harbor, Mass., 788; Saugus River, Mass., 789; Chelsea River, Mass., 790; East Boston Channel, Mass., 793; Neponset River, Mass., 800.

APPENDIX C.

REPORT OF CAPT. W. H. BIXBY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 804; harbor of refuge at Nantucket, Mass., 806; Marthas Vineyard inner harbor at Edgartown, Mass., 809; harbor at Vineyard Haven, Mass., 811; Wareham Harbor, Mass., 813; New Bedford Harbor, Mass., 815; Westport Harbor, Mass., 818; Canapitsit Channel, Mass., 820; Taunton River, Mass., 822; Pawtucket River, R. I., 828; Providence River and Narragansett Bay, R. I., 830; Green Jacket Shoal, Providence, River, R. I., 832; Greenwich Bay, R. I., 834; cove and waterway near Coaster Harbor Island, R. I., 835; Newport Harbor, R. I., 836; harbor of refuge at Point Judith, R. I., 839; entrance to Point Judith Pond, R. I., 841; harbor of refuge at Block Island, R. I., 842; Pawcatuck River, R. I. and Conn., 845; harbor of refuge at Stonington, Conn., 847; removing sunken vessels or craft obstructing or endangering navigation, 849.

EXAMINATIONS.—Woods Holl, Mass., 860; Tarpaulin Cove, Naushon Island, Mass., 864; New Bedford Harbor, Mass., 866; Pawtuxet Harbor, Providence River, R. I., 868; Apponang Harbor, Cowesset Bay, R. I., 869; Greenwich Harbor, Greenwich Bay, R. I., 871; Wickford Harbor, Narragansett Bay, R. I., 873; inner harbor at Point Judith breakwater, R. I., 877; breachway into Salt Pond, Block Island, R. I., 880; Stonington Harbor and its entrance, Conn., 891.

APPENDIX D.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mystic River, Conn., 898; Thames River, Conn., 901; Connecticut River, Mass. and Conn., 906; harbor of refuge at Duck Island Harbor, Conn., 914; Clinton Harbor, Conn., 917; New Haven Harbor, Conn., 919; breakwaters at New Haven, Conn., 924; Milford Harbor, Conn., 929; Housatonic River, Conn., 932; Bridgeport Harbor, Conn., 937; Black Rock Harbor, Conn., 942; Saugatuck River, Conn., 945; Norwalk Harbor, Conn., 948; Wilson Point Harbor, Conn., 950; Five Mile River Harbor, Conn., 952; Stamford Harbor, Conn., 954; Harbor at Cos Cob and Miamus River, Conn., 958; Port Chester Harbor, N. Y., 960; Larchmont Harbor, N. Y., 963; East Chester Creek, N. Y., 965; Greenport Harbor, N. Y., 969; Port Jefferson Harbor, N. Y., 971; Huntington Harbor, N. Y., 975; Glen Cove Harbor, N. Y., 978; Flushing Bay, N. Y., 980; Patchogue River, N. Y., 983; Browns Creek, Sayville, N. Y., 986.
EXAMINATIONS.—Wesport Harbor, Conn., 990; Norwalk Harbor, Conn., 991; Berrians Creek, Long Island, N. Y., 993; Southold Harbor, Long Island, N. Y., 996.
HARBOR LINES.—Shaws Cove, New London Harbor, Conn., 997; Bridgeport Harbor, Conn., 998.

APPENDIX E.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Hudson River, N. Y., 1006; harbor at Saugerties, N. Y., 1019; harbor at Rondout, N. Y., 1021; Wappinger Creek, N. Y., 1024; Harlem River, N. Y., 1025; East River and Hell Gate, N. Y., 1034; Newtown Creek, N. Y., 1044; Buttermilk Channel, New York Harbor, N. Y., 1050; Gowanus Bay, N. Y., 1053; New York Harbor, N. Y., 1060; Jamaica Bay, N. Y., 1069; Raritan Bay, N. J., 1070; removing sunken vessels or craft obstructing or endangering navigation, 1076.
EXAMINATIONS.—Fort Pond Bay, N. Y., 1077; channel west of Robbins Reef Lighthouse to connect the mouth of Arthur Kill with New York Harbor, N. Y., 1083.
HARBOR LINES.—New York Harbor and its adjacent waters, 1085.

APPENDIX F.

REPORT OF CAPT. THOS. L. CASEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Sumpawanus Inlet, N. Y., 1100; Canarsie Bay, N. Y., 1101; Sheepshead Bay, N. Y., 1103; Arthur Kill, N. Y. and N. J., 1104; channel between Staten Island and New Jersey, 1106; Passaic River, N. J., 1108; Elizabeth River, N. J., 1713; Rahway River, N. J., 1115; Raritan River, N. J., 1116; South River, N. J., 1120; Keyport Harbor, N. J., 1123; Mattawan Creek, N. J., 1125; Shoal Harbor and Compton Creek, N. J., 1128; Shrewsbury River, N. J., 1130; Manasquan (Squan) River, N. J., 1133.
EXAMINATIONS.—Seaford Creek, Long Island, N. Y., 1134; channel connecting Freeport with Great South Bay, N. Y., 1136; Whale Creek, N. J., 1138.

PART II.

APPENDIX G.

REPORT OF MAJOR C. W. RAYMOND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River, N. J. and Pa., 1142; harbor between Philadelphia, Pa., and Camden, N. J., 1152; Schuylkill River, Pa., 1164; ice harbor at Marcus Hook, Pa., 1168; ice harbor at head of Delaware Bay, Del., 1169; construction of iron pier in Delaware Bay, near Lewes, Del., 1170; Delaware Breakwater, Del., 1172; Raucocas River, N. J., 1174; Alloway Creek, N. J., 1176; Salem River, N. J., 1178; Goshen Creek, N. J., 1180; removing sunken vessels or craft obstructing or endangering navigation, 1182.
EXAMINATIONS.—Barnegat Inlet, N. J., 1185; Dennis Creek, N. J., 1187; Cooper Creek, N. J., 1189.

APPENDIX H.

REPORT OF WM. F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED.

IMPROVEMENTS.—Wilmington Harbor, Del., 1194; ice harbor at New Castle, Del., 1196; Appoquinimink River, Del., 1197: Smyrna River, Del., 1198; Muderkill River, Del., 1200; Mispillion River, Del., 1201; Broadkiln River, Del., inland waterway from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 1203; Susquehanna River above and below Havre de Grace, Md., 1205; Northeast River, Md., 1206; Elk River, Md., 1207; Fairlee Creek, Md., 1210; Chester River, Md., from Crumpton to Jones Landing, 1211; Choptank River, Md., 1213; LaTrappe River, Md., 1215; Warwick River, Md., 1216; Cambridge Harbor, Md., 1218; Broad Creek River, Del., 1220; Wicomico River, Md., 1222; Manokin River, Md., 1223; Onancock Harbor, Va., 1225; harbor and approaches at Cape Charles City, Va., 1227; removing sunken vessel or craft obstructing or endangering navigation, 1228.
EXAMINATIONS.—Mouth of Saint Jones River, Del., 1229; inland waterway between Mispillion and Broadkiln rivers, Del., 1231; Pocomoke River, Md., with view of uniting it with Synepuxent Bay above Snow Hill, 1234; Nanticoke River, Del., 1236; Black Walnut Harbor, Md., 1239.

APPENDIX I.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Patapsco River and channel to Baltimore, Md., 1243; channel to Curtis Bay in Patapsco River, Baltimore Harbor, Md., 1249; James River, Va., 1251; removing sunken vessels or craft obstructing or endangering navigation, 1262.
EXAMINATION.—South and Middle branches of Patapsco River, Baltimore, Md., 1262.

APPENDIX J.

REPORT OF MAJOR CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Potomac River and Anacostia River at Washington, D. C., 1265; Occoquan Creek, Va., 1281; Aquia Creek, Va., 1286; Lower Machodoc Creek, Va., 1289; Nomini Creek, Va., 1292; Patuxent River, Md., 1294; Rappahannock River, Va., 1296; Urbana Creek, Va., 1301; York River, Va., 1303; Mattaponi River, Va., 1306; Pamunkey River, Va., 1308.
EXAMINATIONS.—Mouth of Parish Creek, Md., 1310; Wicomico River, Md., 1312; mouth of Little Wicomico River, Va., 1315; mouth of Morattico Creek, Va., 1317; mouth of Milford Haven, Va., 1319.

APPENDIX K.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of Norfolk and its approaches, Va., 1323; approach to Norfolk Harbor and the United States Navy-Yard at Norfolk, Va., 1328; Nansemond River, Va., 1329; Chickahominy River, Va., 1331; Appomattox River, Va., 1333; inland water route from Norfolk, Va., to Albemarle Sound, N. C., through Currituck Sound, 1341; North Landing River, Va., and N. C., 1343; removing sunken vessels or craft obstructing or endangering navigation, 1344.
EXAMINATION.—Harbor at Petersburg and Appomattox River, Va., 1345.

APPENDIX L.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Staunton River, Va., 1350; Roanoke River, N. C., 1351; Pasquotank River, N. C., 1354; Mackeys Creek, N. C., 1357; Ocracoke Inlet, N. C., 1359; Fishing Creek, N. C., 1377; Pamlico and Tar rivers, N. C., 1380; Contentnia Creek, N. C., 1385; Trent River, N. C., 1387; Neuse River, N. C., 1390; inland waterway between Newbern and Beaufort, N. C., 1393; harbor at Beaufort, N. C., 1395; inland waterway between Beaufort and New River, N. C., 1397; inland waterway between New River and Swansboro, N. C., 1399; New River, N. C., 1400; North East (Cape Fear) River, N. C., 1403; Black River, N. C., 1407; Cape Fear River above Wilmington, N. C., 1411; Cape Fear River at and below Wilmington, N. C., 1419; Lockwoods Folly River, N. C., 1432; Yadkin River, N. C., 1435; Georgetown Harbor, S. C., 1437; Winyaw Bay, S. C., 1441; removing sunken vessels or craft obstructing or endangering navigation, 1449.
EXAMINATIONS.—Potohunk River, N. C., 1451; Durhams Estuary, N. C., 1454; breakwater at Beaufort, N. C., 1457.

APPENDIX M.

REPORT OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Waccamaw River, N. C. and S. C., 1464; Lumber River, N. C. and S. C., 1468; Little Pedee River, S. C., 1471; Great Pedee River, S. C., 1474; Clark River, S. C., 1477; Mingo Creek, S. C., 1480; Santee River, S. C., 1483; Wateree River, S. C., 1488; Congaree River, S. C., 1491; harbor at Charleston, S. C., 1495; Ashley River, S. C., 1512: Wappoo Cut, S. C., 1514; Edisto River, S. C., 1517; Salkahatchie River, S. C., 1522; Beaufort River, S. C., 1524; removing sunken vessels or craft obstructing or endangering navigation, 1530.
EXAMINATION.—Lynch River, S. C., 1532.

APPENDIX N.

REPORT OF CAPT. O. M. CARTER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Savannah Harbor, Ga., 1536; Savannah River, Ga., 1547; Savannah River above Augusta, Ga., 1554; Darien Harbor, Ga., 1556; Altamaha River, Ga., 1561; Oconee River, Ga., 1567; Ocmulgee River, Ga., 1572; Brunswick Harbor, Ga., 1578; Brunswick Outer Bar, Ga., 1584; Jekyl Creek, Ga., 1590; Cumberland Sound, Ga., 1593; inside water route between Savannah, Ga., and Fernandina, Fla., 1604; removing sunken vessels or craft obstructing or endangering navigation, 1608.
EXAMINATION.—Savannah River, Ga., between Spirit Island and crossing of Charleston and Savannah Railway, 1609.
HARBOR LINES.—Savannah River in vicinity of quarantine station near Fort Pulaski, Savannah, Ga., 1610.

APPENDIX O.

REPORT UPON WORKS IN CHARGE OF MAJ. J. C. MALLERY AND LIEUTENANT A. M. D'ARMIT, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Johns River, Fla., 1613; Upper St. Johns River, Fla., 1646; Volusia Bar, Fla., 1648; Ocklawaha River, Fla., 1651; St. Augustine Harbor, Fla., 1653; Indian River, Fla., 1656; northwest entrance. Key West Harbor, Fla., 1657; Caloosahatchee River, Fla., 1660; channel of Charlotte Harbor and Pease Creek, Fla., 1663; Sarasota Bay, Fla., 1665; Manatee River, Fla., 1668; Tampa Bay, Fla., 1670; Withlacoochee River, Fla., 1674; harbor at Cedar Keys, Fla., 1676; Suwanee River, Fla., 1677.
EXAMINATION.—Harbor at Cape Canaveral, Fla., 1681.

APPENDIX P.

REPORT OF CAPT. PHILIP M. PRICE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Apalachicola Bay, Fla., 1690; Apalachicola River, the Cut-off, and Lower Chipola River, Fla., 1692; Flint River, Ga., 1695; Chattahoochee River, Ga. and Ala., 1698; La Grange Bayou and Holmes River, Fla., 1705; Choctawhatchee River, Fla. and Ala., 1706; harbor at Pensacola, Fla., 1710; Escambia and Conecuh rivers, Fla. and Ala., 1716; Alabama River, Ala., 1718; Tallapoosa River, Ala., 1723; Coosa River, Ga. and Ala., 1724; operating and care of canals and other works of navigation on Coosa River, Ga. and Ala., 1734; Cahaba River, Ala., 1735.

EXAMINATIONS.—Bar at mouth of Alaqua Bayou, Fla., 1738; bar at junction of Choctawhatchee Bay and Santa Rosa Sound, Fla., 1741.

APPENDIX Q.

REPORT OF MAJOR A. N DAMRELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mobile Harbor, Ala., 1744; Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, 1751; Warrior and Tombigbee Rivers, Ala., and Miss., 1755; Noxubee River, Miss., 1763; Pascagoula River, Miss., 1765; Chickasahay River, Miss., 1769; Bluff Creek, Miss., 1770; Leaf River, Miss., 1771; harbor at Biloxi Bay, Miss., 1772; Pearl River below Jackson, Miss., 1774; Pearl River between Carthage and Jackson, Miss., 1777; Pearl River between Edinburg and Carthage, Miss., 1779; Bogue Chitto, La., 1781; removing sunken vessels or craft obstructing or endangering navigation, 1782.

EXAMINATIONS.—Mississippi Sound, 1783; Back Bay, Biloxi, Miss., 1784; mouth of Old Fort Bayou, Miss., mouth of Wolf River, Miss., 1787; mouth of Jordan River, Miss., 1789; Pearl River from Edinburg to Lake Burnside, Miss., 1791; diversion of Pearl River near Jackson, Miss., through Tan Yard Branch, 1792.

PART III.

APPENDIX R.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

INSPECTION of the improvement of the South Pass of the Mississippi River, 1795.

APPENDIX S.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chefuncte River and Bogue Falia, La., 1808; Tickfaw River and its tributaries, La., 1810; Amite River and Bayou Manchac, La., 1812; Bayou Lafourche, La., 1814; Bayou Terrebonne, La., 1817; Bayou Plaquemine, Grand River, and Pigeon bayous, La., 1818; Bayou Courtableau, La., 1821; Bayou Teche, La., 1824; channel, bay, and passes of Bayou Vermillion, La., 1826; Mermentau River and tributaries, La., 1828; mouth and passes of Calcasieu River, La., 1830; harbor at Sabine Pass, Tex., 1832; Sabine River, Tex., 1835; Neches River, Tex., 1837; removing sunken vessels or craft obstructing or endangering navigation, 1839.

EXAMINATIONS.—Homochitto River, Miss., 1839; harbor of refuge on Lake Pontchartrain, La., 1842; connection of bayous Black and Terrebonne between Southdown Plantation and Houma, La., 1845; Sabine River from Sudduths Bluff, Tex., to Logansport, La., 1848; channel through Sabine Lake from Sabine Pass to mouths of Sabine and Neches rivers, Tex., 1850; Neches River, Tex., from its mouth to Shooks Bluff, 1853.

APPENDIX T.

REPORT OF CAPTAIN JOHN MILLIS, CORPS OF ENGINEERS.

IMPROVEMENT.—Securing mouth of Bayou Plaquemine, La., from further caving, 1857.

APPENDIX U.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1861; Ship Channel in Galveston Bay, Tex., 1872; channel in West Galveston Bay, Tex., 1877; Trinity River, Tex., 1880; Cedar Bayou, Tex., 1883; Buffalo Bayou, Tex., 1886; harbor at Brazos Santiago, Tex., 1890;
EXAMINATION.—Brazos River, Tex., from its mouth to Richmond, 1893.

APPENDIX V

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Red River, La. and Ark., 1901; Red River above Fulton, Ark., 1999; Ouachita and Black rivers, Ark. and La., 2002; Bayous D'Arbonne and Corney, La., 2009; Bayou Bartholomew, La. and Ark., 2012; Boeuf River, La., 2015; Tensas River and Bayou Maçon, La., 2018; Big Black River, Miss., 2022; Yazoo River, Miss., 2024; mouth of the Yazoo River, Miss.. 2029; Tchula Lake, Miss., 2038; Tallahatchee River, Miss., 2041; Steele and Washington bayous, Miss., 2045; Big Sunflower River, Miss., 2047; Big Hatchee River, Tenn., 2052; Forked Deer River, Tenn., 2054; water gauges on Mississippi River and its principal tributaries, 2057; survey of Cypress Bayou and the lakes between Jefferson, Texas, and Shreveport, La., 2065.
EXAMINATIONS.—Sulphur River, Tex., 2083; Little River, Ark., 2087; Ouachita River above Camden, Ark., 2091; Cassity Bayou, Miss., 2095; Coldwater River, Miss., 2099.

APPENDIX W.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing obstructions in Arkansas River, 2102; Arkansas River, 2103; Fourche Le Fevre River, Ark., 2108; Petit Jean River, Ark., 2110; White River, Ark., 2111; Cache River, Ark., 2114; Little Red River, Ark., 2115; Black River, Ark. and Mo., 2116; Black River, Mo., 2117; St. Francis River, Ark., 2118; St. Francis River, Mo., 2119; Little River, Mo., removing sunken vessels or craft obstructing or endangering navigation, 2121.
EXAMINATIONS.—Saline River, Ark., 2122; Fourche Le Fevre River, Ark., 2125; Current River, Ark., 2128.

APPENDIX X.

REPORT OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS.

EXAMINATIONS.—Harbor at Memphis, Tenn., including removal of bar forming opposite the upper part of the city, and bank protection along the city front, 2133; Wolf River, Tenn., 2136.

APPENDIX Y.

REPORT OF MAJOR CHAS. J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing snags and wrecks from Mississippi River, 2139; Mississippi River between Ohio and Missouri rivers, 2147; harbor at St. Louis, Mo., 2177; Gasconade River, Mo., 2178; Osage River, Mo., 2182; Kaskaskia River, Ill., 2185.

APPENDIX Z.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Operating snagboats and dredgeboats on upper Mississippi River, 2189; Mississippi River between Missouri River and Minneapolis, 2200; Des Moines Rapids, Mississippi River, 2240; operating and care of Des Moines Rapids Canal and Drydock, 2241.
EXAMINATIONS.—Hamburg Bay, on Mississippi River, Calhoun County, Ill., 2248; Mississippi River, Iowa side, from mouth of Iowa River to Burlington, 2251; Moline Harbor, Ill., 2253; Mississippi River at and near Bellevue, Iowa, 2254; additional harbors of refuge on Lake Pepin, Mississippi River, 2257.

APPENDIX A A.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mississippi River above Falls of St. Anthony, Minn., 2261; reservoirs at headwaters of Mississippi River, 2264; Chippewa River, including Yellow Banks, Wis., 2272; St. Croix River, Wis. and Minn., 2275; Minnesota River, Minn., 2278; Red River of the North, Minn. and N. Dak., 2282; surveys for reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers, 2288; gauging Mississippi River at or near St. Paul, Minn., 2289.

APPENDIX B B.

REPORT OF LIEUT. COL. CHAS. R. SUTER, CORPS OF ENGINEERS.

EXAMINATION.—Kansas River, Kan., 2293.

APPENDIX C C.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Missouri River between the Great Falls, Montana, and Sioux City, Iowa, 2297; removal of snags and other obstructions in Missouri River above Sioux City, Iowa, 2319; examination of Missouri River between Three Forks and Canyon Ferry, Montana, to determine availability of water power, 2320; Yellowstone River, Mont. and N. Dak., 2321.
EXAMINATION.—James River, S. Dak., 2321.

APPENDIX D D.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Obion River, Tenn., 2327; Tennessee River above Chattanooga and below Bee Tree Shoals, 2330; Hiwassee River, Tenn., 2381; French Broad and Little Pigeon rivers, Tenn., 2383; Clinch River, Tenn., 2387; Cumberland River, Tenn. and Ky., 2389; Caney Fork River, Tenn., 2402.
EXAMINATIONS.—Ohio River between Livingston Point and Tennessee Island, 2404; Duck River, Tenn., 2406; Sequatchie River, Tenn., 2408; Hiwassee River, Tenn., 2412; Emory River, Tenn., 2413.

APPENDIX E E.

REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala., 2419; operating and care of Muscle Shoals Canal, Tennessee River, 2431.

APPENDIX F F.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ohio River, 2438; operating snag boats on Ohio River, 2478; operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa., 2481; movable dam in Ohio River below mouth of Beaver River, Pa., 2484; Monongahela River, W. Va., and Pa., 2488; operating and care of locks and dams Nos. 8 and 9, Monongahela River, 2492; purchase of lock and dam No. 7, Monongahela River, 2495; purchase of lock and dam No. 6, Monongahela River, Cheat River, W. Va., 2496; Allegheny River, Pa., 2498; dam at Herr Island, Allegheny River, near Pittsburg, Pa., 2501; ice harbor at mouth of Muskingum River, Ohio, 2502; Muskingum River, Ohio, 2504; operating and care of locks and dams on Muskingum River, Ohio, 2506.
EXAMINATIONS.—Ohio River at or near Elizabethtown, Ill., 2518; harbor at Evansville, Ind., 2520; Ohio River between Ludlow and Covington, Ky., and Cincinnati, Ohio, 2523; Little Miami River, Ohio, for ice harbor, 2525; Ohio River between Ironton, Ohio, and 3 miles along and up the Ohio east of mouth of Guyan River, W. Va., 2527; Raccoon River, Ohio, 2530; location of locks and dams on Ohio River between Davis Island Dam and the dams near mouth of Beaver River, Pa., 2533; lock and dam on Allegheny River between (proposed) dam at Tarentum and Herr Island Dam, Pa., 2535; lock and dam on Allegheny River at or near Tarentum, Pa., 2538; Allegheny River from Olean, N. Y., to Warren, Pa., 2540.

APPENDIX G G.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River, at Louisville, Ky., 2543; Indiana Chute, Falls of the Ohio River, 2549; operating and care of Louisville and Portland Canal, Ky., 2554; Wabash River, Ind. and Ill., 2559; White River, Ind., 2567.
EXAMINATIONS.—Little Wabash River, Ill., 2569; Embarras River, Ill., 2573.

APPENDIX H H.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Great Kanawha River, W. Va., 2577; operating and care of locks and dams on Great Kanawha River, W. Va., 2594; Elk River, W. Va., 2595; Gauley River, W. Va., 2598; New River, Va. and W. Va., 2603.

APPENDIX I I.

REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tradewater River, Ky., Lock No. 2, Green River, at Rumsey, Ky., 2606; Green River, above mouth of Big Barren River, Ky., 2608; operating and care of locks and dams on Green and Barren rivers, Ky., 2609; Rough River, Ky., 2616; Kentucky River, Ky., 2618; operating and care of locks and dams on Kentucky River, Ky., 2622; Licking River between Farmers and West Liberty, Ky., 2630; Big Sandy River, W. Va. and Ky., 2631; Levisa Fork of Big Sandy River, Ky., 2635; Tug Fork of Big Sandy River, W. Va. and Ky., 2637; Guyandotte River, W. Va., 2639; Little Kanawha River, W. Va., 2641; operating and care of lock and dam on Little Kanawha River, W. Va., 2642; Buckhannon River, W. Va., 2644.
EXAMINATIONS.—Licking River, Ky., 2644; bar at junction of Big Sandy and Ohio rivers, 2647.

PART IV.

APPENDIX J J.

REPORT OF MAJOR CLINTON B. SEARS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Grand Marais, Minn., 2651; harbor at Agate Bay, Minn., 2654; harbor at Duluth, Minn., 2657; harbor at Superior Bay and St. Louis Bay, Wis., 2668; Minnesota Point at Superior, Wis., 2673; harbor at Ashland, Wis., 2674; harbor at Ontonagon, Mich., 2677; Eagle Harbor, Mich., 2679; waterway from Keweenaw Bay to Lake Superior, Mich., 2680; harbor at Marquette, Mich., 2686; harbor of refuge at Grand Marais, Mich., 2689.
EXAMINATION.—Allouez Bay and Nemadji River, Wis., 2692.
HARBOR LINES.—Allouez Bay, near Superior, Wis., 2695.

APPENDIX K K.

REPORT OF MAJOR JAMES F. GREGORY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Manistique Harbor, Mich., 2700; Cedar River Harbor, Mich., 2701; Menominee Harbor, Mich. and Wis., 2703; Menominee River, Mich. and Wis., 2706; Oconto Harbor, Wis., 2708; Pensaukee Harbor, Wis., 2710; Green Bay Harbor, Wis., 2711; Sturgeon Bay and Lake Michigan Canal, Wis., 2714; operating and care of Sturgeon Bay and Lake Michigan Canal, Wis., 2718; harbor of refuge at entrance of Sturgeon Bay and Lake Michigan Canal, Wis., 2719; Ahnapee Harbor, Wis., 2721; Kewaunee Harbor, Wis., 2724; Two Rivers Harbor, Wis., 2727; Manitowoc Harbor, Wis., 2730; Sheboygan Harbor, Wis., 2733; Port Washington Harbor, Wis., 2738; harbor of refuge at Milwaukee Bay, Wis., 2741; Milwaukee Harbor, Wis., 2744; Racine Harbor, Wis., 2748; Kenosha Harbor, Wis., 2751; Waukegan Harbor, Ill., 2754; Fox River, Wis., 2758; operating and care of locks and dams on Fox River, Wis., 2766; removing sunken vessels or craft obstructing or endangering navigation, 2777.
EXAMINATIONS.—Green Bay, Wis., from light-house to first bridge on Fox River, 2778; protection wall on canal at Kaukauna, Fox River, Wis., 2779; harbor at Stockbridge, Lake Winnebago, Wis., 2782; harbor at Calumet, Lake Winnebago, Wis., 2783.
HARBOR LINES.—Oconto Harbor, Wis., 2784; Milwaukee River, Milwaukee, Wis., 2788.

APPENDIX L L.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chicago Harbor, Ill., 2791; Calumet Harbor, Ill., 2810; Calumet River, Ill. and Ind., 2815; Illinois River, Ill., 2822; operating and care of La Grange Lock and Dam, Illinois River, Ill., 2830; Illinois and Mississippi Canal, Ill., 2832.
EXAMINATIONS.—Outer harbor at mouth of Calumet River, Ill., 2846; Wolf River Harbor, Ind., 2850.

APPENDIX M M.

REPORT OF MAJOR WILLIAM LUDLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Michigan City Harbor, Ind., 2858; St. Joseph Harbor, Mich., 2864; St. Joseph River, Mich., South Haven Harbor, Mich., 2870; Saugatuck Harbor, Mich., 2874; Holland (Black Lake) Harbor, Mich., 2877; Grand Haven Harbor, Mich., 2879; Muskegon Harbor, Mich., 2885; White Lake Harbor, Mich., 2890; Pentwater Harbor, Mich., 2894; Ludington Harbor, Mich., 2895; Manistee Harbor, Mich., 2897; harbor of refuge at Portage Lake, Manistee County, Mich., 2903; Frankfort Harbor, Mich., 2905; Charlevoix Harbor and entrance to Pine Lake, Mich., 2908; Petoskey Harbor, Mich., 2910; Cheboygan Harbor, Mich., 2917; Thunder Bay Harbor, Mich., 2920; Thunder Bay River (Alpena Harbor), Mich., 2922; Saginaw River, Mich., 2924; harbor of refuge at Sand Beach, Lake Huron, Mich., 2931; Black River at Port Huron, Mich., 2938; mouth of Black River, Mich., 2940; Clinton River, Mich., 2942; Rouge River, Mich., 2946; turning basin in Rouge River, Mich., 2947.
EXAMINATIONS.—Hammond Bay, Mich., 2948; Sebewaing River, Mich., 2950; Pine River at St. Clair, Mich., 2954; Belle River, Marine City, Mich., 2956.
HARBOR LINES.—Black River at Port Huron, Mich., 2958.

APPENDIX N N.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ship channel connecting the waters of the Great Lakes, between Chicago, Duluth, and Buffalo, 2962; operating and care of St. Marys Falls Canal, Mich., 2970; St. Marys River at the Falls, Mich., 2991; Hay Lake Channel, St. Marys River, Mich., 3024; St. Clair Flats Canal, Mich., 3029; operating and care of St. Clair Flats Canal, Mich., 3031; Grossepoint Channel, Mich., Detroit River, Mich., 3034.
HARBOR LINES.—St. Marys River at Sault Ste. Marie, Mich., 3037; Detroit, Mich., 3039.

APPENDIX O O.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 3047; Toledo Harbor, Ohio, 3050; Port Clinton Harbor, Ohio, 3058; Sandusky Harbor, Ohio, 3061; Sandusky River, Ohio, 3065; Huron Harbor, Ohio, 3067; Vermillion Harbor, Ohio, 3071; Black River Harbor, Ohio, 3072; Cleveland Harbor, Ohio, 3075; Fairport Harbor, Ohio, 3081; Ashtabula Harbor, Ohio, 3085; Conneaut Harbor, Ohio, 3089; removing sunken vessels or craft obstructing or endangering navigation, 3093.

APPENDIX P P.

REPORT OF MAJOR E. H. RUFFNER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Erie Harbor, Pa., 3096; Presque Isle Peninsula, Erie Harbor, Pa., 3101; Dunkirk Harbor, N. Y., 3103; Buffalo Harbor, N. Y., 3107; Tonawanda Harbor and Niagara River, N. Y., 3111; Niagara River from Tonawanda to Port Day, N. Y., 3113; Wilson Harbor, N. Y., 3114; Olcott Harbor, N. Y., 3116; Oak Orchard Harbor, N. Y., 3117.
EXAMINATION.—Dunkirk Harbor, N. Y., 3119.

APPENDIX Q Q.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Charlotte, N. Y., 3132; harbor at Pultneyville, N. Y., 3136; harbor at Great Sodus Bay, N. Y., 3140; harbor at Little Sodus Bay, N. Y., 3146; harbor at Oswego, N. Y., 3152; harbor at Sacketts Harbor, N. Y., 3166.
EXAMINATION.—Harbor of refuge in Mexico Bay, N. Y., 3169.
HARBOR LINES.—Oswego Harbor, N. Y., 3178.

APPENDIX R R.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Shoals between Sister Islands and Cross-over Light, St. Lawrence River, N. Y., 3188; Ogdensburg Harbor, N. Y., 3190; breakwater at Rouse Point, Lake Champlain, N. Y., 3192; Great Chazy River, N. Y., 3194; Plattsburg Harbor, N. Y., 3195; Burlington Harbor, Vt., 3196; Otter Creek, Vt., 3198; Ticonderoga River, N. Y., 3200; Narrows of Lake Champlain, N. Y. and Vt., 3201; breakwater construction in Lake Champlain, 3202.
EXAMINATIONS.—North Hero Harbor, Lake Champlain, Vt., 3213; harbor at Adams (Tobias) Landing, Grand Isle, Vt., 3215.

APPENDIX S S.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

IMPROVEMENT.—Oakland Harbor, Cal., 3217.
EXAMINATION.—Entrance to harbor of San Francisco (Golden Gate), Cal., 3221.

APPENDIX T T.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Napa River, Cal., 3223; Redwood Creek, Cal., 3225; San Luis Obispo Harbor, Cal., 3226; Wilmington Harbor, Cal., 3229; San Diego Harbor, Cal., 3231; Colorado and Gila rivers, at Yuma, Ariz., 3234.
EXAMINATIONS.—Twelve-mile Creek, San Francisco Bay, Cal., 3235; Alviso Slough, Cal., 3236; deep-water harbor at San Pedro or Santa Monica Bay, Cal., 3238.

APPENDIX U U.

REPORT OF MAJOR W. H. HEUER, CORPS OF ENGINEERS.

IMPROVEMENTS.—San Joaquin River, Cal., 3265; Mokelumne River, Cal., 3269; Sacramento and Feather rivers, Cal., 3271; Petaluma Creek, Cal., 3276; Humboldt Harbor and Bay, Cal., 3278.
EXAMINATIONS.—San Joaquin River, Cal., from Hills Ferry to Firebaughs Ferry, including closing of sloughs above Stockton, 3290; Old River Branch of San Joaquin River, Cal., 3294; Merced River, Cal., 3297; Tuolumne River, Cal., 3299; Stanislaus River, Cal., 3301; mouth of Navarro River, Cal., 3304; harbor of Crescent City, Cal., 3308; harbor at Yaquina Bay, Oregon, 3314.

APPENDIX V V.

REPORT OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Coquille River, Oregon, 3324; Coquille River, Oregon, between Coquille City and Myrtle Point, 3329; entrance to Coos Bay and Harbor, Oregon, 3332; Umpqua River, Oregon, 3342; mouth of Siuslaw River, Oregon, 3344; Yaquina Bay, Oregon, 3357; Tillamook Bay and Bar, Oregon, 3368; entrance to Nehalem Bay, Oregon, 3371; Upper Snake River, Idaho, between Huntington Bridge and Seven Devils Mining District, 3372; upper Columbia and Snake rivers, Oregon and Wash., 3375; Columbia River, between head of Rock Island Rapids and foot of Priest Rapids, Wash., 3378; Nasel River, Wash., 3399; Willapa River and Harbor, Wash., 3402; Grays Harbor and Chehalis River, Wash., 3408; Chehalis River, Wash., 3414; harbor at Olympia, Wash., 3415; Swinomish Slough, Wash., 3419; Puget Sound and its tributary waters, Wash., 3425.
EXAMINATIONS.—Chetco River, Oregon, 3429; Rogue River, Oregon, 3433; Coos River, Oregon, 3437; Alsea, River, Oregon, 3440; Nestugga River, Oregon, 3446; upper Columbia River, Wash., from international boundary to Rock Islands Rapids, 3452; Kootenai River from Fry, Idaho, to international boundary line, 3456; Spokane River, Idaho, from Post Falls to Lake Cœur d'Alene, 3458; Snohomish River, Wash., from its mouth to Lowell, 3462; Everett Harbor, Wash., including mouth of Snohomish River, 3464; Nooksack River and Bellingham Bay, Wash., 3468.
HARBOR LINES.—Ports in the State of Washington, 3472.

APPENDIX W W.

REPORT OF MAJOR THOS. H. HANDBURY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mouth of Columbia River, Oregon and Wash., 3488; Columbia River between Vancouver, Wash., and mouth of Willamette River, 3503; canal at the Cascades, Columbia River, Oregon, 3506; Columbia and lower Willamette rivers below Portland, Oregon, 3515; Willamette River above Portland and Yamhill River, Oregon, 3522; Cowlitz River, Wash., 3526; Youngs and Klasquine rivers, Oregon, 3527; gauging waters of Columbia River, Oregon and Wash., 3528.
EXAMINATIONS.—Willamette River above Oregon City, Oregon, 3529; Yamhill River from mouth to McMinnville, Oregon, 3531; Lewis River, Wash., from its mouth to Speliah Creek, 3533.
HARBOR LINES.—Columbia River at Flavel, Oregon, 3537.

APPENDIX X X.

REPORT OF CAPT. FREDERICK RODGERS, UNITED STATES NAVY.

SUPERVISION of the harbor of New York, 3541.

PART V.

APPENDIX Y Y.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

C. B. COMSTOCK, Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A., President; CHARLES R. SUTER, Lieutenant-Colonel, Corps of Engineers. U. S. A.; O. H. ERNST, Major, Corps of Engineers, U. S. A.; HENRY L. WHITING, Assistant U. S. Coast and Geodetic Survey; B. M. HARROD, ROBERT S. TAYLOR, and HENRY FLAD, *Commissioners.*
ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1893, 3545.
APPENDIX 1.—Note of Col. C. B. Comstock, Corps of Engineers, on "change of plane" at Red River Landing, 3564.
APPENDIX 2.—Report of Committee on Dredges, 3570.
APPENDIX 3.—Report of Capt. Carl F. Palfrey, Corps of Engineers, Secretary Mississippi River Commission, 3573; (A) report of Assistant Engineer Chas. W. Stewart on secondary triangulation from Port Louisa, Iowa, to near mouth of Galena River, Ill., 3589; (B) report of Assistant Engineer A. T. Morrow, in charge of topographical party for season of 1892, 3600; (C) report of Assistant Engineer A. T. Morrow on tertiary triangulation and stone lines from Donaldsonville to Head of Passes, and precise levels from New Orleans to Head of Passes, 3603; (D) report of Assistant Engineer James A. Paige on precise levels from New Orleans to Head of Passes, 3620; (E) report of Assistant Engineer J. A. Ockerson on inspection of gauges, 3654; (F) highest and lowest gauge readings on Mississippi River and its tributaries and on Atchafalaya River, 1892, 3661; (G) highest and lowest and mean highest and mean lowest stages of Mississippi River from Cairo to Head of Passes, 1872–1892, etc., 3662; (H) mean number of days during which the Mississippi River, from Cairo to Head of Passes, was between certain indicated heights, 1872–1892, etc.; (I) discharge measurements on Mississippi River and its tributaries and on Atchafalaya River, 1892, etc., 3663; (K) report of Capt. Carl F. Palfrey, Corps of Engineers, on study of some early maps of Mississippi River, etc., 3703; (L) commercial statistics, 1892, 3708.
APPENDIX 4.—Report of Capt. S. W. Roessler, Corps of Engineers, on operations in first and second districts, 3713; (A) report of Assistant Engineer W. M. Rees on improvement at Hopefield Bend, 3726; (B) report of Assistant Engineer Aug. J. Nolty of operations at Plum Point Reach, 3731; (C) report of Assistant Engineer C. W. Sturtevant on repairs to plant, 3743.
APPENDIX 5.—Report of Capt. C. McD Townsend, Corps of Engineers, on operations in the third district, 3752; (A) report of Assistant Engineer Arthur Hider on work at Greenville Harbor, Ashbrook Neck, and Louisiana Bend, 3769; (B) report of Assistant Engineer H. St. L. Coppée on work at Vicksburg Harbor, 3784; (C) report of Capt. C. McD Townsend, Corps of Engineers, on comparison of low-water soundings taken through Lake Providence Reach, 1882–1891, 3786; (D) cost of United States levees in Mississippi, Arkansas, and Louisiana, 1882–1893, 3806; (E) statement of Assistant Engineer Arthur Hider of repairs to plant, 3807.
APPENDIX 6.—Report of Capt. John Millis, Corps of Engineers, on operations in the fourth district, 3816.

PART VI.

APPENDIX Z Z

REPORT OF THE MISSOURI RIVER COMMISSION.

CHARLES R. SUTER, Lieutenant-Colonel Corps of Engineers, U. S. A., President; A. MACKENZIE, Major, Corps of Engineers, U. S. A.; O. H. ERNST, Major, Corps of Engineers, U. S. A.; GARLAND C. BROADHEAD and RICHARD S. BERLIN, *Commissioners.*

ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1893, 3921.

APPENDIX A.—Report of First Lieut. J. C. Sanford, Corps of Engineers, Secretary Missouri River Commission, 3929; (1) commerce of the Missouri River between Sioux City and the mouth, 1892, 3932; (2) table of geographical positions, 3942; (3) measurement of bridges, opposite 3944; (4) table of distances, 3944; (5) annual report of Mr. O. W. Ferguson, assistant engineer, 3955; (6) annual report of Mr. James A. Paige, assistant engineer, 4134; (7) annual report of Mr. O. H. B. Turner, assistant engineer, 4218; (8) annual report of Mr. A. H. Blaisdell, assistant engineer, 4221.

APPENDIX B.—Annual report of Mr. S. Waters Fox, division engineer, Omaha Division, 4223.

APPENDIX C.—Annual report of Mr. S. Waters Fox, division engineer, Saint Joseph Division, 4228.

APPENDIX D.—Annual report of Mr. S. Waters Fox, division engineer, Kansas City Division, 4232.

APPENDIX E.—Annual report of Mr. Samuel H. Yonge, division engineer, Kansas City and Osage divisions, 4235.

APPENDIX F.—Annual report of Mr. S. Waters Fox, division engineer, Gasconade Division, 4258.

APPENDIX A A A.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

(1) Report of Capt. Thos. L. Casey, Corps of Engineers, 4267; (2) report of Major Chas. E. L. B. Davis, Corps of Engineers, 4268; (3) report of Major A. M. Miller, Corps of Engineers, 4269; (4) report of Major D. W. Lockwood, Corps of Engineers, 4270; (5) report of Major William Ludlow, Corps of Engineers, 4270; (6) report of Col. O. M. Poe, Corps of Engineers, 4271; (7) report of Major E. H. Ruffner, Corps of Engineers, 4272; (8) report of Major T. H. Handbury, Corps of Engineers, 4273.

APPENDIX B B B.

REPORT OF COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

WASHINGTON AQUEDUCT, 4275; increasing the water supply of Washington, D. C., 4309; erection of fishways at Great Falls, 4310.

APPENDIX C C C.

REPORT OF COL. JOHN M. WILSON, UNITED STATES ARMY.

IMPROVEMENT and care of public buildings and grounds in the District of Columbia, 4313; Washington Monument, 4316.

APPENDIX D D D.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES.

SURVEYS, 4343; correcting engraved plates, 4343; printing and issuing charts, 4343; resurvey of St. Marys River, 4344; discharge of Niagara River, 4364; resurvey of the lake front at Chicago, 4372; survey of shoal at the mouth of the Niagara River, 4378; annual water levels, 4381; water gauge at Ogdensburg from 1869 to 1892, 4384.

APPENDIX E E E.

REPORT OF MAJOR WILLIAM A. JONES, CORPS OF ENGINEERS.

CONSTRUCTION and improvement of roads and bridges in the Yellowstone National Park, 4391.

APPENDIX F F F.

EXPLORATIONS AND SURVEYS IN MILITARY DEPARTMENTS.

REPORT of First. Lieut. Cassius E. Gillette, Corps of Engineers, engineer officer, on operations in Department of the Missouri, 4401; report of Major Tully McCrea, Fifth Artillery, acting engineer officer, on operations in Department of the Columbia, 4402; report of Capt. Charles A. Worden, Seventh Infantry, acting engineer officer, on operations in Department of the Platte, 4403; report of Lieut. Charles G. Lyman, Second Cavalry, in charge of office, on operations in Department of California, 4403.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX Y Y.

ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

ARMY BUILDING,
New York City, June 28, 1893.

SIR: The Mississippi River Commission has the honor to submit its annual report for the fiscal year ending June 30, 1893.

The act approved July 13, 1892, appropriated the following sums to be expended under the Commission:

Improvement of—	
Memphis Harbor, Tennessee	$25,000
Vicksburg Harbor, Mississippi	80,000
Greenville Harbor, Mississippi	100,000
Natchez Harbor, Mississippi Vidalia Harbor, Louisiana	80,000
Atchafalaya and Red rivers	80,000
Mississippi River	2,000,000

The last-named sum was distributed as follows:

Levees	$1,500,000
Channel works (construction)	333,000
Channel works (dredging)	35,000
Plant	110,000
Surveys, gauges, and observations	22,000

Details of allotments are shown in the financial statements.

Transfers of allotments and of previous balances have been made as follows:

The levee system having been redistricted balances of previous allotments for levees was transferred to the new titles. From Plum Point $25,000 has been transferred to rebuilding the steamer *Mississippi*, $15,000 to dredging experiments, and $2,000 to surveys, gauges, and observations.

First and second districts: From the balance for Memphis Harbor has been transferred $7,431.78 to Hopefield Bend. From Ashbrook Neck has been transferred $25,000 to plant for the third district. From the general service its remaining balance of $46,345.33 has been transferred to surveys, gauges, and observations under the secretary.

The act approved March 3, 1893, appropriated the sum of $2,665,000, to be available July 1, 1893.

From this distribution has been made as follows:

Levees	$1,500,000
Channel works (construction)	455,000
Dredging experiments	40,000
Plant	292,000
Surveys, gauges, and observations	132,000
Expenses of Mississippi River Commission	40,000

leaving unallotted $206,000, of which $150,000 is held awaiting the results of the dredging experiments.

Since the last report of the Commission five meetings have been held, as follows: In New York on June 22, August 2, 1892, and June 26, 1893; on the steamer *Mississippi* November 5, 1892, and on the steamer *Gen. Barnard* on May 6, 1893. The two last-mentioned meetings have included inspections of the works.

OFFICE AND SURVEYS, GAUGES AND OBSERVATIONS.

Triangulation.—At the date of the last annual report the triangulation party on May 31, 1892, had reached Fairport, Iowa. Subsequently this work has been extended upstream a distance 116 miles, and to within 9 miles of Dubuque, Iowa, by August 26. This is, at present, the northern limit of the triangulation of the general survey which the Commission is directed to extend from the Head of the Passes to the headwaters of the Mississippi River. This survey, complete in its triangulation, topography, and hydrography, is now finished from the head of the Des Moines Rapids to Donaldsonville, La., 79 miles above New Orleans. The leveling and triangulation is finished to the Head of the Passes.

The survey down to Donaldsonville, done by the Commission in 1883, connected with a survey in 1879, extending up to Donaldsonville from the Head of the Passes, by the U. S. Coast and Geodetic Survey. It was considered advisable, in order to obtain the information which is best given by comparative surveys and to secure uniformity of method and detail, to extend the survey of the Commission from Donaldsonville down to the Head of the Passes. Accordingly a party entered the field at Donaldsonville on December 13, 1892, to make such triangulation as might be found necessary, from lapse of time, in a region which had already been triangulated by the Coast and Geodetic Survey, and to mark the stone lines which form part of our system. Descriptions of triangulation of located points were furnished by the Coast and Geodetic Survey, and enough of them were found to render secondary triangulation unnecessary.

This party reached Kennerville, La., 62 miles below Donaldsonville and 17 miles above New Orleans, on January 12, 1893, and completed the triangulation to the Head of the Passes, an additional distance of 94 miles by the river, on March 15.

Precise leveling.—The foregoing party was sufficiently strengthened at Kennerville to add to its duties the extension of the line of precise levels which the Commission had already run from Duluth and Chicago, on the Great Lakes, across to and down the Mississippi River to New Orleans (with a branch line to tidal level of the Gulf of Mexico at Biloxi, Miss.) down to the Head of the Passes.

The practicability of this extension, as it enters the low and marshy tracts bordering the river near the Gulf, has generally been considered doubtful on account of the instability of the soil. The experience of this party still leaves the work with an uncertain value, and it will be most important to rerun this line, after sufficient time has elapsed to give comparative results, in order to prove the permanence of the bench marks or ascertain the causes of their instability.

Topography and hydrography.—On September 1, 1892, a party entered the field at Hannibal, Mo., to continue the upstream extension of the topography and hydrography of the Commission's survey. By the end of the working season, on November 10, a river distance of 69 miles was covered, and the work was suspended at a point near the head of the Des Moines Rapids, 10 miles above Keokuk, Iowa.

Maps, publications, etc.—The condition and progress of the publication of the charts of this survey may be stated as follows:

The map of the alluvial region, reaching from the Gulf of Mexico up to Cape Girardeau, Mo. (scale 1 inch to 5 miles), is complete in 8 published sheets.

The 1 inch to the mile map is complete from the Head of the Passes to Grafton, Ill., 1,289 miles by river, in 41 sheets.

The charts on a scale of 1:20000 are now complete from Donaldsonville, La., to Grafton, Ill., 1,116 miles by river, in 84 sheets. Four sheets have been issued since the last report.

The charts on a scale of 1:10000 are now complete from Donaldsonville, La., to just above Quincy, Ill., a distance by river of 1,235 miles. Seven have been completed since the last report.

During the year 25 gauges have been maintained in good order by the Commission and daily observations read. The collection, tabulation, and publication of these gauge records, together with others kept by Majors Mackenzie and Allen and by Captains Willard and Taber, of the Corps of Engineers, and by the Weather Bureau, aggregating 32 on the main river and 26 on the tributaries, has been brought down to include the year 1892. An improvement in the construction of gauge bulletins, designed by Assistant Engineer Ockerson, adding materially to their strength and durability, is being made as fast as reconstruction is required.

The publication of the gauging of the main river and of its tributaries, made under the direction of the Commission at different points and stages, has been continued to include the year 1892.

An exhibit, consisting of various maps, observations, and methods of the Commission, has been prepared and placed in the World's Columbian Exposition.

An interesting study and report on eighteenth century maps of the *Mississippi River* has been made by Captain Palfrey, secretary of the Commission. These show great topographical ability on the part of the authors, and indicate that the constant and rapid changes observed in the river are local, and of detail, and mainly caused by cut-offs, and that the great features of curvature are permanently characteristic.

During the year the steamer *Mississippi* lost her upper works by fire, and the *Pete Kirns* was crushed in an ice gorge. The former is being rebuilt and the latter replaced by purchase.

Diligent efforts have been made this year by the secretary and the district officers to collect commercial statistics of the river, and much greater success has been obtained than in previous years. The analysis of the information received from the Mississippi Valley Transportation Company, by the secretary, shows in a clear light the importance of improved low-water navigation. The result of their labor will be found in their several reports and appendices.

Further details of the transactions of the Commission and of its office will be found in the report of Captain Palfrey, secretary, and the several reports of assistant engineers and the appendices attached thereto.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky., 21 miles below Cairo.—This work is intended to protect the front of the town against erosion. It covers 2,200 linear feet of bank and was completed in 1891. It has accomplished its purpose, and, at present, requires neither repairs nor extension.

Hickman, Ky., 36 miles below Cairo.—At this point the hills reach the

river, and on and below them the city is located. For several years caving of the alluvial bottom lands, both above and below the bluff, had been going on rapidly, while the harder hill formation has successfully resisted the attack of the current. At one time there was a railway terminus above the bluff, but this was abandoned before appropriations for the improvement were made. Therefore, from the small value of the land above the hill, from the great extent of work which would have been required to protect it, and because the bluff made a safe head for the work, a project was adopted for starting a revetment there, extending 1,000 feet downstream. This work was built in 1890 and has accomplished its purpose. It is possible that an extension both in width and length may be required as the floods have damaged the lower end and increased the depth along its outer edge. The repairs so far necessary at the lower end have been made and additional ballast placed on the shore mats.

New Madrid, Mo., 71 miles below Cairo.—The project for this improvement consists of a revetment along the front of the town, from Dry Slough downstream, to protect it against erosion. The stone for the work has been delivered on the bank, and construction will commence as soon as the water has fallen sufficiently to make it practicable.

Plum Point Reach, 147–186 miles below Cairo.—This reach has a length of about 40 miles. The several works designed for its improvement are detached and consist of continuous and interrupted revetments of spurs, dikes, and training walls. These are all intended to coöperate in confining and directing the channel throughout the limits of the reach. Reference is here made, in detail, to each of these works and its present condition, in geographical order, beginning at the upstream end.

Daniels Point revetment.—This revetment was commenced in 1888, to maintain the conditions and direction in which the river entered the reach. At that time about one mile was built, with the intention of extending it upstream, in subsequent years, as far as might prove necessary. Slight repairs were required during the fiscal year ending June 30, 1892, and others of a more extensive character have been necessary during the past year. The work is in a very exposed position and, owing to the short length of bank covered, is liable to serious attack on either flank. All repairs were repeated on March 1, 1893, and the work is now in good order. Preparations are made to extend it 1,000 feet upstream during the early summer.

Ashport Bend revetment.—At the date of the last report this revetment had been extended downstream to a point 6,750 feet below Ashport. Its extension has been actively pushed during the working season of the past year, and by February, 1893, when work was suspended by high water, 8,504 additional feet of bank had been covered. This leaves only about 4,000 feet to complete this part of the project. Considerable difficulties were encountered on this work, in some parts owing to the unstable nature of the soil and in others from the great number of cypress stumps, both of which added much to the time and cost of grading. The mats below low water range in width from 200 to 240 feet.

Gold Dust dikes.—These dikes remain as they were described in the report of 1891. No further work is now contemplated, as the projected dikes in Elmot and Island 30 chutes will better accomplish the results that would be gained by their maintenance.

Fletchers Bend revetment.—This work, commenced in 1884, had reached at the time of our last report a continuous development of 12,900 linear

. Below this was three detached pieces, aggregating about 3,300 , practically giving a length of 17,400 feet of protected bank. It is posed to connect these detached pieces as soon as circumstances will mit, and an allotment is made for that purpose. The repairs required ing the past year have been unimportant.

Elmot and Island 30 chutes.—It has been necessary to postpone so the construction of the dikes across Elmot and Island 30 chutes. s work is now proposed as part of the operations of the coming son. These will be low-water dams, intended to turn the low-water r from these by-ways, and divert it into the main channel, for the provement of Fletchers and Elmot crossings. An allotment has n made for the purpose and the required amount of stone has been ivered on a convenient part of the bank. The object of these dikes been to a certain extent anticipated by sinking mats, heavily bal-ed with stone, over the drift racks accumulated in the chutes.

Plum Point revetment and dikes.—No work has been done or is at sent intended here.

Osceola revetment.—At the date of last report this work had a length ,500 feet, which is apparently sufficient for protecting the bar.

Osceola and Bullerton dikes.—No work has been done or is at present nded here.

Bullerton revetment.—This is one of the earliest revetments built by Commission. It had a width of only 100 feet. It has done good vice, but recent changes in the channel have subjected it to a strain ich makes it necessary that it should be largely if not entirely rebuilt h greater width and strength.

Levees.—The only levees at present in this engineer district are in vicinity of Plum Point, in connection with the channel improvement. An allotment of $264,000, under the provisions of the act of July 13, 2, has been made for the levees of the lower St. Francis Basin, from nt Pleasant to Helena, with a frontage of 228 miles. Surveys and tracts will be made as soon as practicable after the overflow, to com-nce the construction of the levees of this district, beginning at Bear ou and extending upstream as far as the allotment will permit.

Surveys, gauges, and observations.—During the year the usual surveys e made in this district in connection with the works of channel provement and with levees. Special surveys were made of a shoal ssing near New Madrid, and of the lower portions of the Wolf and oosahatchie rivers, in connection with Memphis Harbor. Also spe-l examinations, by soundings, have been made of the revetments of s district, with the view of ascertaining the condition of such work, l the cause of such defects as might be detected. The results of s and similar examinations made in the other districts will be dis-sed in another part of this report. All details of these examinations h an important discussion, as well as of all other transactions in this trict will be found in the appended report of Capt. S. W. Roessler, harge of the district, and in the reports of his assistant engineers. High or low water discharge measurements were made at Columbus, .; New Madrid, Mo.; Fulton, Tenn., and Helena, Ark.

OND DISTRICT (ISLAND 40 TO MOUTH OF WHITE RIVER, 180 MILES).

Hopefield Bend, Ark., 225 miles below Cairo.—The revetment built this bend is intended to coöperate with the local work along the rt of Memphis Harbor. It was commenced in 1882, and has, year year, except when revetment work was interdicted by Congress,

been carried to a completion in 1889. Such injuries have been caused by floods and such repairs made as have been described in previous reports. After the flood of 1892 repairs aggregating 4,200 linear feet and the strengthening of about 1,300 feet were found necessary. This was done during the past low-water season, but other breaks, four in number and aggregating 1,600 feet in length, have occurred during the past flood.

Memphis Harbor, 230 miles below Cairo.—Without the holding of Hopefield Bend by the revetment just reported on the harbor of Memphis by this time would have been largely obstructed by the extension of the sand bar below Old Hen Island. As it is this bar has encroached on the front so as to overlap the paved landing about 150 yards. The other harbor works, consisting of 7,500 feet of revetment and 2,000 feet of spur protection, have accomplished their object and continue in good order.

Nonconnah Rocks, 256 miles below Cairo.—Contract has been made for the removal of this obstruction to the channel on the left of Presidents Island, to a depth of about 8 feet below low water, during the coming season.

Helena Harbor, 306 miles below Cairo.—This work remains in the condition described in the last report of the Commission. It consists of 600 linear feet of revetment and five spurs, covering a frontage of about 3,000 feet, which includes the most important part of the harbor. The lower end of this work is still incomplete, but the objects sought seem fairly established and no further work is in contemplation at present.

Levees.—In this district are included the lower part of the lower St. Francis Basin, to which allusion has been made in the report on the first engineer district, also the Upper Yazoo levee district, 244 to 365 miles below Cairo, and the levee districts in the White River Basin, 306 to 385 miles below Cairo. The levees of the Upper Yazoo levee district, about 120 miles long, are in a higher state of efficiency than those of most other parts of the system. They have generally grades 3 or 4 feet above the highest recorded water, full crowns and sections, and banquettes where the height makes it advisable. No crevasse has occurred in this district for the last two years. The work of the past year has been an enlargement of section over 5 miles, and the construction of a new levee about 1½ miles long at a point threatened by caving. The proposed work for the coming year is a further enlargement of about 10 miles and the construction of a new levee about 3,500 feet long.

The work done in the past year by the General Government was 503,448 and by the local authorities 439,106 cubic yards.

The White River Basin, extending from Helena to the mouth of White River, about 78 miles of frontage, comprises a projected system of levees throughout its length. Work on these has been commenced on both the upper and lower ends, as giving the most immediately valuable results in protection from overflow. At the date of the last report the upper section extended about 21 miles below Helena and the lower section was about 19 miles long, leaving a gap of about 24 miles. During the year this gap has been reduced about 4 miles, and a long section of existing levees has been raised and strengthened. These levees, as far as built, are generally of fair grade and section. It is proposed during the coming year to reduce the intervening gap as much as the allotment will permit.

Surveys, gauges, and observations.—The surveys necessary for information concerning several works and the condition of the river in the dis-

trict have been made during the year, and also many borings to gain information concerning the character of the soil at depths to which the channel reaches and to which revetments must necessarily extend. Special surveys of revetments such as were described in the first district were everywhere made and will be discussed hereafter.

Full accounts of the operations of this district will be found in the reports of Capt. S. W. Roessler and of his assistant engineer, and in their appendices.

THIRD DISTRICT (FROM WHITE RIVER TO WARRENTON, MISS., 220 MILES.)

Lake Bolivar front, 417 miles below Cairo.—This work, consisting of 4,400 linear feet of revetment, intended to protect the Lake Bolivar levee and its site, was completed in 1889. It has accomplished its purpose. During the coming year it is proposed to make the necessary repairs, which are slight.

Ashbrook Neck revetment, 446 miles below Cairo.—This important work had in view the prevention of a cut-off at the upper end of the narrow necks, formed by the remarkable series of reverse curves in the river just above Greenville, and known as "The Bends." It was apprehended that a cut-off at this point would, by shortening the local length, so increase the slope and velocity of the river that the rate of caving would be much augmented, other cut-offs would occur, the harbor of Greenville be destroyed, many miles of levee lost, and a general disturbance induced of the conditions of this part of the river which are now tolerably stable and quite favorable for navigation. The work was designed to consist of a continuous revetment 8,000 feet long with a width of 300 feet below low water, or as near that as is practicable. Work was commenced in 1890, during which season 2,820 feet were laid. During the next year, besides the repairs which were necessary at the lower end of the previous season's work, an extension of 2,500 feet downstream and 1,500 upstream was made. During the past season the work was completed by a further upstream extension of 2,610 linear feet. To assist in the same object a spur dike or levee was built down the axis of the point to obstruct the overflow across the neck. Although this part of the work was badly damaged by the floods it accomplished an important result by accumulating a large quantity of drift and sand. No further work is now contemplated at this point.

Greenville Harbor, 478 miles below Cairo.—The object of this improvement is the protection from caving of the bank on which the city of Greenville is built. The first project proposed only the construction of a series of spurs along the city front. This was accomplished in the years 1887, 1888, and 1889. They gave an immediate local result, but it was soon recognized that the caving in the bend above was so rapid that, to preserve the existing work and the city, it was necessary to extend a revetment upstream until a stable bank was reached. This was commenced in 1891, during which year 6,600 linear feet of mat work, similar to that at Ashbrook Neck, was laid. During the past season 4,450 feet have been added. It is proposed to continue the work as fast as circumstances will permit.

Lake Providence Reach, 512–572 miles below Cairo.—The reports of the last and previous years have given full details of the various works of channel improvement comprised in the system for the rectification of this reach. At the date of the last report the revetment of Louisiana Bend, commenced in 1889, had a length of 11,024 feet, all in good

order. During the past year 5,835 feet have been added, making a total length of 3½ miles. Notwithstanding the destruction of many of the earlier works built in this reach, and the failure of the continued operation of others by the extensive caving in bends opposite the contraction works, which it was not in the power of the Commission to prevent, partly from lack of funds and partly from legislative restrictions, the beneficial results secured for navigation are not lost. It is not proposed to continue any work in this reach during the coming season for reasons that will be given hereafter.

Vicksburg Harbor and Delta Point, 599 miles below Cairo.—Since the cut-off of the point opposite Vicksburg in 1876 a persistent and successful effort has been made to prevent the caving of Delta Point. Any further recession of this point would not only add to the commercial disadvantages under which this city rests as the result of the cut-off, but would also very materially increase the cost and difficulty of any plan that can be devised for the improvement of the harbor. The maintenance of this point has therefore been regarded as the key of the situation to which all other features were subordinate. Besides this work at Delta Point the dredging of a canal of navigable width and depth at the lowest stages, leading from the main channel of the river into the east end of the lake formed by the cut-off and along the commercial front of the city, was undertaken in 1887. To protect it against silt-bearing currents in higher stages a dike is being constructed, with excavated material across the lake at the head of the canal, and has now reached a height of 25 to 35 feet above the zero of the Vicksburg gauge.

The Delta Point revetment has been successful and is now in efficient order. Its permanence is, however, threatened by a very considerable increase of depth from scour along its outer edge. It is therefore proposed, during the coming working season, to increase the width and take all other necessary precautions for the preservation of this mat work.

The results of dredging in the canal have not been encouraging, more particularly in the last two years, during which 559,721 cubic yards have been excavated and a refill of 298,000 yards, or over 53 per cent, has occurred. The total excavation since 1887 should have given a prism with a contents of 1,416,165 cubic yards, of which only about 1,000,000 yards, or 70 per cent, can now be found. It will be observed that the fill has occurred at an increasing rate as the excavation has been deepened.

The river and harbor bill of July 13, 1892, adopted the plan of Capt. J. H. Willard, Corps of Engineers, for an improvement of Vicksburg Harbor, and made an appropriation for its execution. This project contemplates the diversion of the Yazoo River from its present outfall into the east end of Centennial Lake and along the city front. When this plan is put in execution the dike under construction by the Commission, across the head of the canal to protect it against silt-bearing currents, will be an obstruction which it will be necessary to remove. But, in view of the past experience in dredging, it is evident that an exclusion of the sediment-charged flow is necessary to the success of the canal. The Commission therefore recommends that no further work be done upon the dike across the head of the canal, and, also, in view of the importance of this dike to the successful completion and maintenance of the canal, that further dredging be suspended.

Levees, Lower Yazoo district.—This district is on the left bank, with a river frontage of 215 miles and a development of levee line of about

190 miles. With that of the Upper Yazoo district it completes the protection of the Yazoo Basin. The levees of the district have generally comparatively fair grades, crowns, and slopes, with banquettes on the land side where the heights are great. They have successfully withstood the great floods of 1892 and 1893 without a break. During the last fiscal year the Government work has consisted in raising and strengthening about 20 miles of the line to standard grade and dimensions. Similar work will be prosecuted under the allotment for the coming working season over about 30 miles.

Upper Tensas district.—This district is on the right bank of the river, extending from the Arkansas River down to the Louisiana line. It has a length of about 85 miles. The head of the system rests on moderately high land on the bank of Amos Bayou, about 7 miles back from the Mississippi at Lucca Landing. This location gives fair protection to the Tensas Basin against flood coming exclusively down the Mississippi, but when the Arkansas is in flood at the same time a large volume escapes around the head of those levees into the Tensas Basin. This overflow in 1892 amounted to 300,000 cubic feet per second. The Commission has now under advisement plans of extension to prevent this condition of affairs. The general condition of this line of levees is very far inferior to those heretofore described on the Yazoo Basin front. While the levees recently built both by the General Government and by the State authorities of Arkansas and Louisiana are of standard grade and section, yet many old-time levees are still remaining which were topped during the last two floods and have very weak sections. The length of these deficient parts was estimated during the flood of 1892 at about 40 miles. This has been materially reduced during the past year by the placing of 1,203,000 cubic yards of earth by the General Government. Similar work will be prosecuted during the coming low-water season by the building of about 1,100,000 cubic yards. Even with these expenditures there will still remain in this district about 25 miles of low-grade and weak levees, which are an annual source of danger and expense. During these same periods about 250,000 cubic yards have been placed and undertaken by the State organizations.

There have occurred in this district from the flood of 1893 four crevasses.

Middle Tensas district.—This levee district is on the right bank and is continuous with the Upper Tensas, from the Louisiana State line down to a point opposite Warrenton, Miss., 10 miles below Vicksburg. It has a levee length of 87 miles. While the grades and sections of these are generally rather better than those of the Upper Tensas, yet many of them require very material improvements to make them safe, and many more are threatened with caving in the very near future, and large expenditures will be required within the next two or three years, if not sooner, to preserve the continuity of the line. This caving is graphically shown in the plate accompanying the report of Assistant Engineer Ockerson (Appendix 4 F, Report 1892) on the relative rate of caving in different parts of the river.

During the past year the General Government has built 460,000 and the State organizations 258,000 cubic yards of levee in this district.

During the present flood there has occurred one crevasse at Wylys. This is a most disastrous one, having an observed discharge of 200,000 cubic feet per second. This, with the crevasses in the Upper Tensas district, all discharge into the Tensas Basin, and the overflow is collected and returned into Lower Red and reaches the Gulf through the Mississippi and Atchafalaya rivers. In this emergency the General Govern-

ment has rendered efficient assistance in the supply of labor and material and in inspection, patrolling, and other services which could be best rendered by the steamboats and barges under the control of the district officer.

Surveys, gauges, and observations.—Full surveys have been made during the year of all the works of channel improvement in this district, also many levee surveys. Discharge observations have been taken at Arkansas City and Wilsons Point, on the Mississippi, and also on the Arkansas and White rivers.

As in the first and second districts, special examinations have also been made here into the condition of the revetments of the district. The results of these, with important discussions, are presented in the appendices containing the reports of Captain C. McD. Townsend and his assistant engineers. In these appendices full details will be found of all the transactions in this district. The results of the special examination of revetment work will receive consideration in another part of this report.

FOURTH DISTRICT (WARRENTON, MISS., TO HEAD OF PASSES, 484 MILES).

Natchez, Miss., and Vidalia, La., Harbors, 700 miles below Cairo.—This improvement will consist mainly of bank revetment, intended to avert a cut-off through the point above the harbors in question, by which the Vidalia bank would be badly eroded, and a sand bar formed in front of Natchez. As the appropriation was entirely insufficient to undertake a very large amount of revetment required, it was determined by the Commission to confine the year's operation to the construction of a spur levee, to prevent the injurious and dangerous flow in high water across the point. Surveys for this have been completed and the work will be done as soon as the high water sufficiently subsides.

Rectification of the Red and Atchafalaya rivers, 761 miles below Cairo.—The condition of affairs remains the same at this point as was described in the last report of the Commission. The project for improvement has also been set forth in full detail in previous reports.

At the approach of low water and during September, 1892, three dredges were employed in maintaining the channel from the Mississippi, through lower Old River, into the Red and Atchafalaya. Notwithstanding every effort navigation was entirely suspended from October 1 until early in November and was not freely reopened until the 19th of that month.

During the year the Commission has contracted for the building of a dredge boat specially designed for work in upper Old River on the adopted project for meeting the requirements of several acts of Congress on the subject. This boat will be completed before the low-water season, when dredging will be commenced in upper Old River. The balance of the appropriation on hand, after paying for this dredge, may not be more than sufficient for temporary work in maintaining navigation during the low-water season through lower Old River. As soon as sufficient funds are available for the completion of the dam it is proposed to take advantage of the expressed willingness of the steamboat men of the Red, Atchafalaya, and Ouachita rivers, mentioned in our last report, to relinquish the use of the old channel and suspend their trade for the time during which it will be necessarily obstructed by the raising of the dam to a sufficient height to divert a large part of the low-water

discharge to the north of Turnbulls Island, and thus coöperate with the dredging operations in opening that channel.

New Orleans Harbor, 963 miles below Cairo.—The project for the improvement of this harbor contemplates, almost exclusively, the protection against caving of the banks of the river, by spurs and revetments. The condition of the river and its banks within the limits of this harbor is one of comparative stability, when compared with the extraordinary changes which occur above and below Vicksburg. But, owing to the valuable improvements located immediately on the banks of the harbor and the enormous commerce to which they minister, any change which, in other localities, would be of slight importance, becomes here a most serious matter, involving the loss of wharves, warehouses, public streets, factories, and other valuable real estate, as well as restricting and impeding both interstate and foreign commerce.

It may also be observed that the methods of improvement which have been applied to this harbor have proved generally effective, as far as the limit of appropriations have permitted their application. There exists great need for the early extension of similar work of improvement down the Carrollton Bend to Audubon Park, from St. Ann to Esplanade street, for an increased number of spurs in the Third Municipal district, and for work at the Algiers Point. In all these places, where valuable properties and interests are located, erosion, more or less rapid, but always destructive, is going on. In some cases the damage in one year of erosion has exceeded the cost of permanent improvement.

During the past year work has been confined to the placing of continuous bank revetment in the intervals between the completed dikes in the Carrollton Bend at Southport, at which point the short radius of curvature makes the attack of the current so direct and the slope of the bank so abrupt as to render this additional precaution advisable.

A part of the appropriation of $80,000 (for two years) was necessarily expended in new barges and repairs to the plant.

Levees.—The levee work in this engineer district has largely increased during the past year, and a redistribution of the levee districts within its limits has been found convenient. The titles of the several allotments have been accordingly changed. A detailed description of the season's operations will be found in the reports of Capt. J. Millis and of his assistant engineers.

Several improvements have been made in the methods of construction, which are described therein.

The titles, lengths, and limits of the levee districts, as rearranged within the engineer district, are as follows:

Lower Tensas, right bank, from Warrenton to Red River, 146 miles of river, of which 130.5 are leveed.

Atchafalaya, right bank, from Red River to the Lafourche, 121 miles, entirely leveed.

Lafourche, right bank, from Lafourche to New Orleans, 78 miles, entirely leveed.

Barataria, right bank, from New Orleans to the Head of Passes, 80 miles, of which 70 is leveed.

Pontchartrain, left bank, from Baton Rouge to New Orleans, 124 miles, entirely leveed.

Lake Borgne, left bank, from New Orleans to Head of Passes, 90 miles, of which 80 miles is leveed.

The work done during the past year, including contracts under way,

but not completed, by the General Government in rebuilding and raising and enlarging to standard grade and section is as follows:

District.	Miles of levee length.	Miles improved this year.	Cubic yards.
Lower Tensas	130.5	23.90	590,350
Atchafalaya	121	5.72	677,290
Lafourche	78	5.91	461,711
Barataria	70	12.28	782,806
Pontchartrain	124	11.43	415,646
Lake Borgne	80	8.72	361,346
Total	603.5	67.96	3,289,149

It will be seen that within the past year's operations over 11 per cent of the levees of the district have been improved by the General Government. The work of the State organizations in the same limits during the year 1892 has comprised the raising and enlargement of 101.5 miles, or about 17 per cent, of the several lines, all to standard grade and dimensions except 24 miles, which were temporarily improved.

The flood of 1892 caused twenty-five breaks in this engineer district, all of which were below Red River, and all of which, except five, were promptly closed. Belmont and Sarpy were disastrous crevasses in the Pontchartrain levee district. Anchor, in the same district, did but little additional damage, while Story and Villere, in the Lake Borgne district, were quite local in their effects.

From the flood of 1893, of equal magnitude to that of the previous year, there is but one crevasse remaining open, viz, at Rescue. This will probably prove disastrous in part of the Pontchartrain district.

Much improvement and success were attained in 1892 in closing crevasses; but the art has not yet reached a point of sufficient certainty and economy to justify its application except where the conditions are very favorable.

During the floods of 1892 and of this year the General Government has rendered much assistance by the supply and transportation of materials to threatened points in the line as well as by the rapid and careful inspection of levees which the district officer was best able to make with the towboats and barges under his control.

During the past year the levees of this engineer district have been substantially improved, from the efficient coöperation of the General and State authorities, but much remains to be done to bring them to a condition of safety for more than an average flood.

Surveys, gauges, and observations.—During the year usual high and low-water discharge observations have been made at Carrollton, and Red River, on the Mississippi, and on the Red and Atchafalaya rivers. Surveys are being made at and below Belmont and Sarpy crevasses of 1892, with a view of ascertaining, by duplicating these surveys after the present flood, the effect upon the bed of the main river caused by the loss of volume through these crevasses. The usual harbor and levee surveys have been made during the year, while special surveys, directed by the Commission, have been made between Warrenton and Grand Gulf, Rodney, and Coles Creek, and back of Lake Bruin and St. Joseph.

Reference for further information concerning the operations of this engineer district is made in the report of Capt. J. Millis, and the reports of his assistant engineers.

REVETMENTS AND DREDGING.

During the past year special examinations have been made of all the bank revetments in each of the districts where they have been built to ascertain defects of construction or change of condition caused by them. These surveys have disclosed the fact of a general deepening from scour along the outer edges of the mats. In some cases the mat has adjusted itself to the new condition, as was intended, while in others the test of its flexibility has been too great and faults have occurred. In some places, also, there has been settlement in the middle of mats rather than along their edges, indicating that greater thickness or density is required in very exposed situations. Defects have also been found between the low-water mats and those built on the graded bank. Under the strain of the long-continued floods of recent years the injury suffered by the revetment work has been sufficient to require a modification of some of the details of construction of bank protection.

The history of this work, under the Commission, is one of progressive increase in size and strength of structures employed as the necessity for such increase has been developed and as, by invention and the skill which comes from experience, the building and handling of larger and stronger structures has become possible. The mattresses used in the lower Mississippi for five years past have been the heaviest and widest ever made for like purpose in the history of engineering. To build and sink them in the deepest and swiftest stream upon which such improvement has been attempted is an undertaking of extreme difficulty. It could not have been done successfully in the earlier stages of the improvement.

These works have always accomplished the results intended in their construction. The holding of a caving bank has always contributed to the improvement in the channel. The one open question of the whole problem of low-water improvement upon the lines hitherto followed is the permanence of the works employed for bank protection. In this respect there is more to be desired than has been attained.

Upon careful consideration of the subject the Commission believes it advisable to further modify the construction of mattresses used in revetment work with a view to securing more flexibility and greater density in certain parts that are particularly exposed, and a better connection between the mats above and below low water, at the same time retaining the strength and general methods of construction and handling. This will involve additional cost. But, believing it to be warranted by the importance of the work, the engineers in charge have been directed to adopt methods to secure these ends in the work of the coming season. With these modifications of structure other and additional safeguards will be introduced.

In view of these facts and conclusions it has been recommended that, during the coming working season, new revetment work be confined to Plum Point Reach and Hopefield Bend.

These considerations, and the recommendation to which they lead, may involve a delay in the present methods of channel improvement which the rapidly increasing demand for better low-water navigation can not stand. The Commission has therefore had under consideration for the past year the subject of temporarily dredging such bars as may, during each low-water season, limit the navigable depth between Cairo and Red River. After very full study they have devised a plan and are building an experimental dredging plant on the lines which they think are most likely to accomplish this purpose. This will be large

enough to demonstrate satisfactorily the feasibility or otherwise of affording relief to commerce by this class of work. It is recognized that to be at all efficient this dredging must be done on a scale rarely, if ever, previously attempted. The character of dredge to be used, the manner and possible speed of working, and above all the best method of disposing of the dredged material, are points of great importance which must be settled before the great cost of the final plant required should be incurred. The experimental dredge now building is designed to throw light on these points as far as possible. It is expected that it will be completed in time to be used during the low water of the present season. The Commission has, therefore, also reserved from other allotments a sum sufficient to construct a dredge boat of sufficient size and capacity to fully apply the results of these experiments on the practicability of the temporary improvement of navigation by such means.

HIGH WATER OF 1893 AND LEVEES.

The volume of discharge of the flood of 1893 was of very much more than average magnitude and it is possible in this respect, after the discharge measurements are prepared, that in some parts of the river it may rank among the very great floods. The volume contained between levees was greater than ever before. The following dates and stages at different localities on the main river and its tributaries show clearly the sources from which the contributions were received:

	Feet.
Cincinnati, May 2	50.6
Chattanooga, May 6	28.2
Nashville, May 9	19.9
St. Louis, May 3	31.5
Cairo, May 9	49.3
Little Rock, May 3	25.2
Alexandria, May 27	24

The northern tributaries of the Ohio, the St. Francis, White, and Yazoo were also excessively high during the month of May. It will thus be seen that very large discharges combined from all flood-making sources, except the Tennessee and the Cumberland, which did not rise much above a half-flood stage.

The high water resulting from these sources in 1893 was in many respects similar to that of the previous year. Both came exceedingly late in the season, and later in 1893 than in 1892.

The resemblance between the floods is also noticeable in the fact that between Arkansas City and Vicksburg and below Red River greater absolute heights were reached than were ever recorded before, and greater relative heights than were observed in either year above Arkansas City.

The greater heights of these floods in the parts of the river above mentioned is to be mainly if not entirely attributed to the larger volume of discharge held between the levees by their improved condition.

Notwithstanding the substantial equality in the flood heights of the past and present high water the number of crevasses in 1893 have been less than ever before whenever any such stage prevailed, and several districts have entirely escaped overflow. The number of unclosed crevasses in 1892 was ten, with an aggregate open length of 10,982 feet, or about one in 550 miles. During the present flood there have been six unclosed crevasses. The aggregate length of these is not yet ascer-

tained, nor is the information yet in the possession of the Commission to prepare a complete statement of the area of land overflowed, as compared with previous years, although the indications are that it will be less. It may be well, in connection with this review of the high water of 1893, to briefly describe the existing levee system, its conditions, results, and requirements. Below the junction of the Mississippi and Ohio the hills crowd closely to the left bank and prevent any large escape of high water as far down as Memphis. Here no general system of levees exists or is required. On the right bank below Cairo lies the St. Francis Basin, extending from Cape Girardeau, Mo., to Helena, Ark. It is drained by the St. Francis River and Bayou St. John. This large region has never been protected from overflow, and only now are coöperative measures being taken by the General Government and the local organizations to inaugurate a system of levees. On the left bank, a short distance below Memphis, and on the right bank, at Helena, begin the existing levee systems. That on the left bank extends down near to Vicksburg and protects the Yazoo Basin. It is in good condition, generally having strong sections and grades from 3 to 4 feet above high water. It withstood the floods of the years 1892 and 1893 without a break, although the flood of 1882, when the water was from 2 to 3½ feet lower along the front of the basin, there were 149 crevasses. The levee system on the right bank, from Helena down to White River, is intended to protect the White River Basin, and is now in process of construction. When completed it will have provisionally efficient grades and sections. Below the Arkansas River, and still on the right bank, lies the Tensas Basin, extending to Red River, 330 miles, partly in Arkansas and partly in Louisiana. A line of levees extends along the entire front of this basin. These levees are by no means in a condition equal to those on the left bank and crevasses have been of annual occurrence. Much work is still required to bring them to a state to safely resist floods equaling those of the past two years.

Below Red River the levees extend on the right bank to about 70 miles below New Orleans, while on the left bank, owing to the proximity of the hills, they only commence at Baton Rouge, from which point they also extend to about 70 miles below New Orleans. Although these levees on both banks have been recently much improved, yet no year has passed without crevasses on one side or the other, and much work is still required to make them efficient.

It has appeared to the Commission to be a wise policy in levee building, owing to the extent of the work and the limited amount applicable to it in any one year, to promptly close all breaks as soon as practicable after their occurrence, in order to maintain the continuity of the line, and to build as long an extent of levee as possible, with a provisional grade and strength sufficient to resist the high waters that recur with substantial regularity, in order to give the earliest and widest protection, even if this protection is not absolute. This course commands itself rather than to build levees at present to an estimated grade and strength which will be sufficient to confine the entire discharge of the greatest future floods, and, in the meantime, to leave unimproved long stretches that will be breached by every ordinary high water. The levee authorities of all the riparian States concur in and act upon this line in their yearly work. It is believed that the wisdom of this policy has already proved itself by the increased coöperation which is coming from local sources, by the increase of acreage under cultivation and of

the value of land, and also of population in many of the districts, and by a greater feeling of confidence in those who live behind levees.

The effect of such improvement as has already been made has been to confine between levees a much larger high water volume, amounting, in some localities, as at Lake Providence, to an increase of 40 per cent. Accompanying this increase of volume is, of course, an increase of flood height. The extreme instance of this is again found at Lake Providence, where the flood rise of the river has increased, since the improvement of the levees, 3.5 feet, or about 8 per cent. A statement of the same tenor applies to Baton Rouge, where the increase of flood rise has been 2.45 feet, or 7 per cent, although during the floods of 1892 and 1893 the entire discharge at Red River Landing upwards of 1,300,000 cubic feet per second has, owing to the improvement of the levees of the Atchafalaya District, been transmitted past Baton Rouge. In all previous years when any such discharge passed Red River disastrous breaks above Baton Rouge materially reduced the volume passing the latter point.

Undoubtedly greater heights will occur when a still larger proportion of high water discharge is controlled between levees and when abnormal floods, such as in 1862 or 1882, occur, but in the meantime the improvement of the levees undertaken and approaching completion in some basins, and well advanced in all, brings in sight a condition of the levee system that will give substantial relief and protection in all except years of unusual floods. The measure of prosperity thus induced will help to supply the resources for the final completion and maintenance of the work.

To any other system for the protection of these alluvial lands there are objections, both theoretical and practical, which can not be overcome. Those of a theoretical character are connected with the hydraulic law that a reduction of flood discharge in a silt-formed channel will reduce its capacity below the point of outlet. This observation has been repeated in the many local comparative surveys of the river bed made by the Commission before and after crevasses, or before and after rebuilding the levee made necessary by a crevasse. The difficulties of a practical nature consist of the necessity of continuing any outlet to the Gulf without return to the river at any intermediate point. Such return would merely transfer the danger from one locality to another lower down. The condition thus imposed upon any outlet involves great cost and danger. Any outlet intended to relieve the parts of the river where flood heights are now most dangerous would, in any case, be very long. To have an appreciable effect it would require an excavated channel of large width and depth. As it would traverse tracts of cultivated and valuable land the cost of expropriation of a right of way would be very great. The cost of the levees which would be required to control it and prevent the permanent continuation of disaster and overflow while flowing through regions which will in a few years be placed under the sufficient protection of a levee system would be very much greater.

When completed there would be two or more rivers, each presenting the same dangers and requiring the same treatment as the present single channel. The cost of efficient outlets would be greater than the cost of completion of the levee system. When constructed they would either silt up, as do many island chutes, or would enlarge and assume the tortuous type of an alluvial stream, with shifting bars and caving banks. Finally, conceived and executed in defiance of physical

law, they would fail as a safe, cheap, or efficient method of abating overflow.

After a review of the progress thus far made in the improvement of a levee system and of the facts developed by the continued surveys, gaugings, and observations of the river, such as the entire absence of evidence of any rise of the bed of the river, the local tendency to shoal where volume is reduced, and the larger discharge now controlled between levees, with an increase of flood heights which does not affect the practicability of a low system, the Commission expresses its continued confidence in the reclamation from overflow of the alluvial lands of the Lower Mississippi Valley on the lines now proposed and in progress, as entirely practicable, at a cost which is amply justified by the importance of the undertaking.

LOW WATER OF 1892.

During the summer and autumn of 1892 the gauge readings were by no means so low as those of the previous year, which, generally, have not been equaled since 1879. The condition of the navigation is shown in the following abstract of bar depth between Cairo and Red River, where 10 feet or less were found:

Depth.	Number of places.
5½	2
6	2
6½	3
7	5
7½	5
8	7
8½	3
9	11
Total	38

FINANCIAL STATEMENT.

Appropriation for salaries and expenses Mississippi River Commission:	
Balance on hand May 31, 1892	$138.26
Balance on hand May 31, 1893	138.26
Appropriation for survey of Mississippi River:	
Balance on hand May 31, 1892	7.08
Balance on hand May 31, 1893	7.08
Appropriation for improving Mississippi River:	
Balance on hand May 31, 1892	986,375.18
Appropriated, act of July 13, 1892	2,470,000.00
Total	3,456,375.18
Expended, June 1, 1892, to May 31, 1893	2,653,471.92
Balance on hand May 31, 1893	802,903.26
Distributed as follows:	
Levees	194,193.70
Channel works	81,559.60
Harbors and bank protection	245,199.19
Red and Atchafalaya rivers	139,973.00
Surveys, gauges, and observations	38,880.67
Plant, Mississippi River Commission, and miscellaneous	103,097.10
Total	802,903.26
Approximate outstanding liabilities and amounts covered by existing contracts	295,492.82

Estimate of funds by the Mississippi River Commission for the fiscal year ending June 30, 1895.

For improving Mississippi River from head of the passes to the mouth of the Ohio River, including salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$2,665 000
For improving harbors at:	
New Madrid, Mo	75, 000
Memphis, Tenn	100, 000
Greenville, Miss	200, 000
Vicksburg, Miss. (Delta Point)	150, 000
Natchez, Miss., and Vidalia, La	400, 000
New Orleans, La	300, 000
For improvement at head of Atchafalaya and mouth of Red River, Louisiana	350, 000

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen., U. S. A.,
President Mississippi River Commission.
CHAS. R. SUTER,
Lieut. Col. of Engineers.
B. M. HARROD,
R. S. TAYLOR,
O. H. ERNST,
Major of Engineers.
HENRY FLAD, C. E.,
HENRY L. WHITING,
U. S. Coast and Geodetic Survey.

BRIG. GEN. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Concurring in the inadvisability of an attempt to create new outlets from the Mississippi River which shall be large streams at all stages of the river, we do not wish to be understood as condemning the use in the levees of long waste weirs to take off the top of the flood if it shall be found that at certain places in the lower part of the river the further increase in flood flow which will come from raising the levees at points farther up the river can be controlled in whole or in part by such waste weirs more economically than by higher levees.

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen. U. S. A.
President Mississippi River Commission.
O. H. ERNST,
Major of Engineers.
HENRY FLAD, C. E.,
HENRY L. WHITING,
U. S. Coast and Geodetic Survey.

The signatures of Henry Flad and Henry L. Whiting have been added at their request.

C. B. C.

LIST OF APPENDIXES ACCOMPANYING THE ABOVE REPORT.

Appendix		Page.
	1. Note on "change of plane" at Red River Landing, by Gen. C. B. Comstock	3564
	2. Report of committee on dredges	3570
	3. Report of Captain Palfrey, secretary of the Commission	3573
	A.—Report of Assistant Engineer Stewart on secondary triangulation from Port Louisa to Galena River	3589
	B.—Report of Assistant Engineer Morrow on work of topography	3600
	C.—Report of Assistant Engineer Morrow on triangulation from Donaldsonville to Head of Passes	3603
	D.—Report of Assistant Engineer Paige on precise leveling from New Orleans to Head of Passes	3620
	E.—Report of Assistant Engineer Ockerson on inspection of gauges	3654
	F.—Highest and lowest gauge readings, 1892	3661
	G.—Highest and lowest and mean highest and lowest stages 1872–'92	3662
	H.—Mean number of days during which the Mississippi River was between certain indicated heights, 1872–1892	3663
	I.—Discharge measurements, 1892	3663
	K.—Study of some early maps of the Mississippi River	3703
	L—Commercial statistics, 1892	3708
	4. Report of Captain Roessler on operations in the first and second districts	3713
	A.—Report of Assistant Engineer Rees on improvement at Hopefield Bend	3726
	B.—Report of Assistant Engineer Nolty on operations at Plum Point Reach	3731
	C.—Report of Assistant Engineer Sturtevant on repairs to plant	3743
	5. Report of Captain Townsend on operations in the third district	3752
	A.—Final report of Assistant Engineer Hider on work at Greenville, Ashbrook Neck, and Louisiana Bend	3769
	B.—Report of Assistant Engineer Coppee on work at Vicksburg	3781
	C.—Comparison of low water soundings, Lake Providence Reach	3786
	D.—Cost of United States levees in Mississippi, Arkansas, and Louisiana	3806
	E.—Statement of repairs to plant	3807
	6. Report of Captain Millis on operations in the fourth district	3816

LIST OF PLATES ACCOMPANYING REPORTS.

Secondary triangulation, Port Louisa to Gordons Ferry, Iowa.
River stage bulletin.
Location of gauges (16 sheets).
Course of the Mississippi from Balise to Fort Chartres (Ross, 1765).
Draft of the Mississippi from Balise to Fort Chartres (Pitman, 1770).
Map of the Mississippi from the Missouri to the mouth (Collot, 1826).
Comparative diagram of meander lines, Mississippi River.
Map of Plum Point Reach.
Vicinity of Memphis, Tenn.
Levee locations, second district.
Improvement at Ashbrook Neck.
Improvement at Greenville.
Chart of Lake Providence Reach.
Improvement at Louisiana Bend.
Hydrographs, Lake Providence Reach (2 sheets).
Regimen elements, Lake Providence Reach.
Velocity observations at Louisiana Bend.
Velocity observations at Shipland.
Chart of Vicksburg Harbor.

Sections of canal and basin, Vicksburg.
Profile of Mississippi levees.
Profile of Arkansas and Louisiana levees.
Typical section of Middle Tensas levees.
Natchez and Vidalia—survey of Cowpen Point.
Red and Atchafalaya. Improvement at Turnbull Island.
New Orleans Harbor, bank protection, Carrollton Bend.
New Orleans Harbor, survey, Southport to Exposition Wharf.
Levees, Lower Tensas and Big Black districts.
Levees, Atchafalaya, Lafourche, and Pontchartrain districts.
Levees, Barataria and Lake Borgne districts.
Levees, method of closing crevasses in.
Levees, typical sections, Fourth district.
Map of Fourth district, showing crevasses and overflowed area.

APPENDIX 1.

NOTE BY COL. C. B. COMSTOCK, CORPS OF ENGINEERS, ON "CHANGE OF PLANE" AT RED RIVER LANDING.

NEW YORK, *May 24, 1893.*

To the Mississippi River Commission:

1. In a paper by Colonel Suter, printed in the Annual Report of the Mississippi River Commission for 1891, in speaking of the Mississippi at the mouth of Red River, he states as follows, p. 3420: (1) "In December and January, 1884–'85, a very abrupt change of plane took place, as shown on both the gauge relation and the discharge curve, and this change was found to coincide with a considerable rise in Red River, the Mississippi being at quite a low stage. This change of plane or elevation of the zero of discharge curve, amounted to 5.8 feet, and inspection of Plate VIII [XI], will show that this elevation was substantially retained throughout the season and on it was superposed the changes of plane, amounting to 3.35 feet more which were transmitted down from Helena and Arkansas City."

And on p. 3422 he states: (2) "These tables show, in a general way, that in every year noted there is an abnormal elevation of the plane of flow at extreme stages, both at Carrollton and Red River. At the latter place this abnormal elevation has amounted to as much as 13 feet; at the former place to 5.4 feet. They also show that if the levee system had been perfect from Vicksburg to Carrollton, the actual mean maximum gauge reading at Red River Landing would have been increased 0.43 feet, and at Carrollton 1.11 feet, while under the same conditions, but with Red River shut out, the actual mean maximum at Red River Landing would have been reduced 7.29 feet and at Carrollton 2.09 feet. Consequently with the levees all up, the difference in mean maximum between the conditions with Red River open and closed would amount to 7.72 feet at Red River Landing and 3.20 feet at Carrollton; the actual maximum differences being 13 feet for Red River Landing and 5.4 feet for Carrollton."

The paper gives many other instances of what are called changes of plane, but it is difficult to follow or verify the discussions by which they are derived, the discussions including a large use of graphic processes in fitting assumed discharge curves to observed discharge curves, or assumed right lines to curves of equivalent gauge relation. Under such circumstances the process can best be examined by taking an instance in which a large result is obtained. That quoted in the first statement above, namely, that in December and January, 1884–'85, an abrupt change of plane of 5.8 feet took place at the mouth of Red River will be chosen.

"Change of plane" is defined as "such as might have been expected, were the whole river bodily raised or depressed so as to change its plane of flow, the gauge remaining fixed in position." As such a bodily elevation or depression would not, necessarily, change the discharge, it would appear that "change of plane" is really difference of gauge readings for two equal discharges at different times at the same place, a phenomenon which was noticed by Dupuit many years ago, and which arises mainly from changes in slope.

The evidence on which this "change of plane" of 5.8 feet at Red River mouth in January, 1885, is based may be found on Plate V and Plate XI of the paper.

2. The relation between the readings of two gauges on the Mississippi River at a distance from each other can be readily studied by plotting their simultaneous readings as an abscissa and ordinate. The succession of points thus obtained will define an irregular curve, showing, graphically, the relation in question. If the gauges are

very near each other, the curve will be a very regular one, nearly a right line inclined at 45 degrees to the axis of abscissas. For gauges widely separated the curve will be very irregular. For instance, the curve obtained in this way for the gauges at Arkansas City and Red River Landing, which are 327 miles apart, is very irregular. The time required for the crest of a flood wave that does not rise above the banks of the river to travel over this distance, is about 4¼ days. Now, when the river is rising rapidly on account of the time required for transmission to the lower gauge, there may be a considerable rise at Arkansas City, and a smaller rise at Red River Landing, and this difference in rises will give a corresponding irregularity in the curve, which shows the relation between the readings at the two gauges. Thus, between December 14, and December 20, 1884, the rise at Arkansas City was 10 feet, while at Red River Landing it was but 1.5 feet, giving an irregularity in the curve of 8.5 feet. When the river begins to fall rapidly at Arkansas City, and is falling slowly at Red River Landing, a similar irregularity in the curve will occur, but in the opposite direction.

Now, if the assumption could be correctly made that the same discharge that passed Arkansas City on a given date would pass a point just above the mouth of Red River 4¼ days later, it might be expected that these equal discharges would give gauge readings having a more regular relation to each other than simultaneous gauge readings would have; and, in that case, if in plotting the curve to express graphically the relation between the gauge readings at the two places, readings on the lower gauge 4¼ days later than those on the upper were used, the irregularity in the curve, due to the fact that the river rises earliest at the upper station, would, in part at least, be eliminated. A curve for 1884–'85 obtained in the last way is given on Plate v, accompanying Colonel Suter's paper. It is marked "Arkansas City, Red River Landing actual gauge relation." This curve has great irregularities, and that it must have great irregularities could have been foreseen.

(*a*) The assumption that the same discharge would occur on a given date at Red River Landing as occurred 4¼ days before at Arkansas City, and that the curve ought to be regular, would not be true, even if all tributary inflow were excluded, unless the river were at a stand for this distance, since wave forms vary much in descending the river.

(*b*) If the tributary inflow were excluded, and the discharges at the two places, at their respective dates, were the same, the gauge readings at the two places would not vary regularly, unless the slopes of the water surface were constant or varied regularly and slowly through long periods. From the general expression for river discharge, $D=Cwr^{\frac{2}{3}}s^{\frac{1}{2}}$, where D is the discharge, C approximately a constant, r the mean depth, w the width, and s the slope, it is seen at once that, while D is constant, and w constant for moderate variations in depth, a given percentage of increase in s will produce an equal percentage of decrease in $r^{\frac{2}{3}}$, or, for constant discharge, the mean depths will vary inversely as the cube roots of the slopes. Now, at Red River and Arkansas City it is known that the slopes sometimes vary rapidly by 10 per cent or more, and the corresponding variation in the gauge reading at mid stage (the discharge remaining the same) would be 4 per cent of 40 feet or 1.6 feet, 40 feet being about the mean depth at mid stage. This gives an irregularity in the curve of "actual gauge relations," if it occurs at but one of the stations, of 1.6 feet. If it occurred at both, and in opposite directions, the amount of the irregularity would be still greater.

(*c*) It is well known that the river bed rises on bad shoals during high water, and is cut out during low water. This process affects the heighth of the gauge reading for a given discharge at low stages, and in some degree also at high stages. It may affect distant gauges quite differently.

(*d*) Thus far it has been assumed that there was no inflow between Arkansas City and Red River Landing. In fact the Red River, the Big Black, and the Yazoo are tributaries. Now as, at mid stages, at Red River Landing an increased discharge of 27,000 cubic feet corresponds to 1 foot of gauge increase, it will be seen that the tributaries may introduce very large irregularities into the gauge readings at Red River Landing as compared with those at Arkansas City. At Helena, Little Rock and Vicksburg, between December 27 and December 31, 1884, the rainfall exceeded 9 inches.

3. The general causes acting to produce marked irregularities in the curve of "actual gauge relations" have now been examined. A glance at this curve for Arkansas City–Red River Landing, on Plate v of Colonel Suter's paper, will show what great irregularities they produce. The most marked one is that which occurred between December 23 and December 30, 1884, Arkansas City dates, the corresponding dates at Red River Landing being 4¼ days later. It is contained in Plate v, between the readings 16 and 24 feet on the Red River gauge. It will now be considered.

From December 23 to December 30, at Arkansas City, the gauge fell from 18.4 feet to 16.5 feet, or 1.9 feet, its lowest point being 15.3 feet on December 28, 1884.

Between the corresponding dates at Red River Landing, namely, December 27¼, 1884, and January 3¼, 1885, the gauge reading there rose from 16.2 to 23.3, or by 7.1 feet. Now, as the oscillations are about the same at Arkansas City and Red River Landing, a regular curve of "actual gauge relations" would have required a fall of 1.9 feet at Red River corresponding to the fall at Arkansas City. Instead there was a rise of 7.1 feet, making the aggregate irregularly 9 feet in the relative gauge readings, corresponding to an irregularity of about 8 feet parallel to the Red River Landing gauge, in the curve of "actual gauge relations." Is there anything surprising in this? Anything requiring the assumption of two parallel lines, (1) and (2) drawn 5.8 feet apart on the curve of "actual gauge relations," Plate v, giving a "change of plane" of 5.8 feet?

If the gauge curves from Cairo down be examined, it will be seen that a depression of about 3 feet, caused by a slight fall above Cairo, descending the river, interrupted the general winter rise already begun. The crest of the low wave thus formed passed Arkansas City on December 23, at 18.4 feet on the gauge, and the depression following reached 15.3 feet on December 28. In descending the river this depression gradually became less below Arkansas City, and when it reached Red River Landing caused no fall, but brought the river there for one day to a stand.

The fact that at Arkansas City, between December 23 and December 27, the river could fall 2.6 feet in five days, without producing any fall at Red River 4¼ days later, shows the inaccuracy of the opinion that the same flow that passes Arkansas City on a given date will pass Red River 4¼ days later, and that, without tributary inflow, it will give a regular curve of actual gauge relations.

From December 18 to December 30, at Red River Landing, the river had risen steadily, under the sole influence of the Mississippi above, since the Alexandria gauge read only 3.2 feet on December 28. But the Alexandria readings rose to 28.2 on the 31st, and this flood of about 80,000 cubic feet per second was added to the Mississippi, it being supposed that the Black supplied the Atchafalaya, since the Ouachita was high. This 80,000 cubic feet per second would cause the Mississippi to rise about 3 feet, and would reach Red River Landing December 31 to January 2. This rise began on December 29, and then was probably due to local rains.

It is thus seen that of the irregularity of 8 feet parallel to the Red River Landing gauge, in the curve of "actual gauge relation," Arkansas City, Red River, on Plate v, between December 23 and 30, Arkansas City dates, 1.0 foot is accounted for by the fall at Arkansas City coming from above Cairo, and 3 feet by the rise of the Red River, leaving 4.0 feet, which is accounted for by the general rise coming from above in the seven days at Red River between December 27¼, 1884, and January 3¼, 1885, a rise of but 0.6 feet per day, while from December 18 to December 27, before the Red River flood, the gauge reading had been rising 0.9 per day. It is then seen that this great irregularity is fully accounted for without the assumption of unknown causes or changes of plane and since the actual changes in the gauge readings are accounted for, the same explanation covers the irregularities in the curve of "equivalent gauge relations" which is yet to be considered, since that curve is derived from actual gauge readings by eliminating differences in discharge. It should also be noticed that of this great irregularity of 8.0 feet, only 3 feet are accounted for by tributary inflow; the rest is mainly due to the tapering out of a small wave of depression in descending the river. The effect of this wave can be separated from that of the inflow at Red River in another way by considering it before the Red River flood affected the Mississippi.

The Red River rise only began at Alexandria on the 28th, and on the 29th the stage was but 10 feet. This rise could not have affected the Mississippi seriously before the 31st December, and till that time the change in tributary inflow may be neglected as small. Now, between the 27th and 31st December, 1884, the river rose 3 feet at Red River Landing, while in the corresponding period, 4¼ days earlier, at Arkansas City, it fell 2.4 feet. Under the assumption that the same flow passes Red River Landing (tributary inflow being excluded) as has passed Arkansas City 4¼ days earlier, the fall of 2.4 feet should have been repeated at Red River. The river there actually rose 3 feet, giving an irregularity in the difference of gauge readings of 2.4+3.0=5.4 feet, due mainly to the tapering out of the low wave already referred to. This irregularity of 5.4 feet simply measures the error in the assumption that gauge readings at Red River Landing can, when there is no tributary inflow, be accurately derived from those of another gauge 327 miles above at Arkansas City.

4. In the preceding sections it has been seen that the attempt to derive (on the assumption that the water passing Arkansas City on a given date passes Red River Landing 4¼ days later) a regular curve which shall give, even with an approximation to accuracy, the relation between the gauge readings at the two places for dates differing by 4¼ days has entirely failed. And this failure is little less conspicuous when the effect of the Red River flood is eliminated, the failure being due to error in the assumption and not to irregularities in the observations or to anything abnormal in the river.

Another method of approaching the subject would be to make the assumption that, if differences of flow at the two stations were eliminated by means of the discharge curves, then a regular curve representing the gauge relation ought to result. We have the discharge curves for Red River Landing and Arkansas City in 1884–'85. Taking the gauge readings on the two curves which correspond to a common arbitrarily selected discharge, if these two gauge readings be plotted as abscissa and ordinate, respectively, one point of a curve showing the relation between those gauge readings will be obtained. Deriving many such points in the same way, they give essentially the curve shown on Plate v of Colonel Suter's paper, and entitled "Arkansas City–Red River Landing, equivalent gauge relations." It will be noticed that this curve is very irregular. There is a great irregularity from December 27 to January 4, 1885, Red River dates; after January 4 the irregularities are not great.

In forming an estimate of the irregularities to be expected in such a curve of "equivalent gauge relations," two errors are to be considered, either of which will introduce irregularites. (*a*) Errors in the discharge observations at either Red River Landing or Arkansas City (which are arbitrarily selected) will give corresponding errors in the gauge heights. Now, irregularities of 10 per cent frequently occur in observed discharges. As the Red River Landing discharge at this time was about 400,000 cubic feet per second, 10 per cent of it would be 40,000 cubic feet per second, corresponding to an irregularity in the gauge reading of 1.3 feet, which irregularity would enter the curve of "equivalent gauge relations." An equal error in the opposite direction at Arkansas City would give an aggregate irregularity of about 2 feet in the curve of equivalent gauge relations, parallel to the Red River gauge, from this cause alone. (*b*) If the observed discharges arbitrarily selected to plot this curve were exact, in order that the curve might be regular it would be further necessary that the slope at these two stations at the times of the selected discharges should have regular values, since, as already seen, the gauge readings corresponding to a given discharge vary approximately with the inverse cube root of the slope. Slopes frequently vary by 10 per cent or more in a few days. Since the slope, as well as the mean depth, is effective in increasing discharge, if for a selected discharge the slope should be 10 per cent above its regular value the mean depth would be 4 per cent below its regular value. Since the mean depth at both places at this time was about 40 feet, the irregularity in gauge reading would be 1.6 feet. If this irregularity occurred in opposite directions at the two stations it would introduce an irregularity into the curve of equivalent gauge relations of about 2.7 feet.

It is seen, then, in advance, that from the methods by which the curve of equivalent gauge relations is derived large irregularities may occur in it, either from errors in discharge or from irregularities in slope. As instances in point, the fall from Natchez to Port Hickey, which gives approximately the slope at Red River, was on December 26, 1884, 20.6 feet, while on January 1, 1885, it was 18.1 feet, or it was 12 per cent less at the later date. Between these dates the river rose from 16.1 to 20.3 at Red River Landing, and if the slope had followed its usual course it would have increased instead by about 3 per cent. The slope was then irregular by 15 per cent. To carry the same discharge this slope irregularity of 15 per cent would require the mean depth to be increased by 5 per cent, or 2 feet. Hence, in this period, the Red River abscissas of the curve of "equivalent gauge relations" become greater by that amount in consequence of change of slope, and give a corresponding irregularity to the curve.

Between December 23 and January 1 the decrease in slope from Natchez to Port Hickey was still greater, amounting to 20 per cent, although the Red River gauge readings rose 6 feet, giving an irregularity in the slope of 24 per cent, which would produce an irregularity of 8 per cent of the mean depth, or 3.2 feet in the Red River Landing gauge readings, plotted in the curve.

Between December 22 and December 31, 1884, are found the discharges at Arkansas City used in Col. Suter's paper, which are equal to those observed between December 26, 1884, and January 1, 1885, at Red River Landing. Any irregularity in the slopes in Arkansas City between December 22 and December 31 would produce a corresponding irregularity in the corresponding gauge readings. Between these dates the fall from White River to Greenville, which gives approximately the slope at Arkansas City, increased from 23.9 to 25.3 feet, or by 1.4 feet; allowing 0.2 foot as the increase of fall due to 1.6 rise in the river, there remains 1.2 feet, or 5 per cent, as an irregular increase. This would give an irregular decrease of 0.8 in the Arkansas City gauge reading to be combined with the irregular increase at Red River Landing of 2.0, giving a resulting irregularity in the curve of equivalent gauge relations of about 3 feet. It is thus seen that from known causes irregularities in the curve of the equivalent gauge relations, Arkansas City–Red River Landing, on Plate v, of about 3 feet, may be expected. Further, if this irregular curve be examined it will be seen that the whole of it can be represented by a single continuous straight line, not deviating from any part of it by more than 2 feet. If for any reason it were desirable to use a line simpler than a regular continuous curve, such a straight

line might, therefore, well be taken, although the actual curve, with all its irregularities, would be better. Instead of representing it by one straight line the paper represents it by five parallel straight lines, which are discrepant with each other by 5.8 feet, and even by 6.2 feet. This 5.8 feet is called a "change of plane," and it is suggested as a possible cause that the Red River water partly fills the channel like mud or sand, and that the Mississippi water is forced to climb on top of it. It is evident that a single straight line, not deviating from the curve anywhere by amounts greater than could have been expected in advance, is a far better representation of all the observations than a series of parallel lines, some of them 6.2 feet apart, measured parallel to the Red River gauge. Had this curve of equivalent gauge relations been plotted from the actually observed discharges, instead of from numerous arbitrarily assumed curves (Plate XI and Plate IX), it might have been represented throughout by a conic section deviating from the observations by only about 1½ feet.

The inducement to the representation by many parallel lines seems to have been the fact that the upper and lower parts of the curve can be pretty well represented by such lines, provided the middle part of the curve be rejected. No reason is assigned for such rejection, and no reason is given for assuming that the lines or the different parts of the curve should be parallel and disconnected. Neither the rejection nor the assumption is justifiable. If G and G^1 represent the equivalent gauge readings at Arkansas City and Red River Landing, their ratio, to give straight parallel lines for the curve of equivalent gauge relation, must be constant.

The general formula for discharge, $D = c\, w\, r^{\frac{2}{3}}\, s^{\frac{1}{2}}$ may be written $r = \frac{D^{\frac{3}{5}}}{C^{\frac{3}{5}}\, w^{\frac{3}{5}}\, s^{\frac{3}{10}}}$,

or if width, w, be considered constant, and $\frac{1}{C^{\frac{3}{5}} w^{\frac{3}{5}}} = c^1$, $r = c^1\, D^{\frac{3}{5}}\, s^{-\frac{3}{10}}$. Similarly, for

the lower station, $r = C^{11}\, D^{\frac{3}{5}}\, s^{1\ -\frac{3}{10}}$, in which, if the gauges are so set as to read mean depths at medium stage, G being a gauge reading and G^1 another with a time

interval, $\frac{G}{G^1} = \frac{r}{r,^1} = \frac{c^1}{c^{11}}\, \frac{s^{1\ -\frac{3}{10}}}{s^{11\ -\frac{3}{10}}}$ since equal discharges are used.

It is seen from this that, since the slope has very wide variations in value at Red River, as compared with those at Arkansas City (varying from nearly 0 to the maximum), $\frac{G}{G^1}$ can not be constant as the river rises, and hence that the correct curve of equivalent gauge relations can not be one or several parallel straight lines.

It should be noticed that the part of the curve before December 30 could be well represented by a nonparallel line, which, prolonged to the gauge reading of January 6, would give at that time a "change of plane" of but 3.6 feet, instead of the 5.8 feet derived in the paper. It must be concluded that the actual irregularities of the curve, when referred to a single right line, are no greater than could have been anticipated, and that the "change of plane" of 5.8 feet arises in the main from the assumption that the curve ought to be two parallel straight lines 5.8 feet apart, which well represent separate parts of the curve, but do not represent, even approximately, the whole curve.

5. This same "change of plane" of 5.8 feet is also derived from the Red River Landing discharge curve of 1884–'85, given on Plate XI, or rather, not from the curve itself but from certain assumed curves numbered from 1 to 10, Plate XI. The interval in the direction of gauge readings between No. 1 and No. 5 of these curves is again the "change of plane" of 5.8 feet. But if the interval between No. 1 and No. 6 be taken it is 9.3 feet, and this is also a "change of plane." The reason why the discharge curves give a change of plane of 9.3 feet while the curve of equivalent gauge relations for the same place and time give only 6.2 for the change of plane is not stated.

The method by which the ten curves are derived is as follows: A regular curve, which represents well the discharge observations of 1882 at Helena (and does not represent those of 1884–'85), is taken, and is called a "standard normal curve." As previously stated, if observed discharge curves for two stations be taken, and for any chosen common discharge on the two curves the corresponding gauge readings be taken, these are called "equivalent gauge readings." Now, a so-called "normal curve" of discharge for gauge readings being known for an upper station, a "normal curve" for a lower station is obtained in this paper by plotting the discharge at the upper station to the corresponding equivalent gauge reading at the lower station. This is called a transfer by a line of gauge relations.

It is important to notice that if we start from a single continuous discharge curve at the upper station, such as the observations give, and plot its discharges to the equivalent gauge readings (derived from the actually observed discharge curve) at the lower station, since this equivalent gauge reading is the actual gauge reading at

the lower station for the actual chosen discharge, by such plotting we reproduce identically the observed discharge curve at the lower station.

Now, in Plate XI, Red River discharges, 1884–'85, curve 1, from which "changes of plane" are derived, differs very widely from the observed discharge curve, and the question at once arises as to the method by which it has been obtained. The answer is that the part of it lying below 19 feet on the gauge has practically been derived from curves 1 and 2, Arkansas City discharges, Plate IX, and from line 1, Arkansas City–Red River Landing equivalent gauge relations, Plate V. The lines and curves referred to on Plates V and IX represent pretty closely, for gauge readings below 19 feet, the actual observations, and hence in Plate XI this part of curve 1 reproduces pretty closely the observed discharge curve at Red River Landing below 19 feet on the gauge. But the part of curve 1, Plate XI, above 19 feet is derived from curve 1, Arkansas City discharges, Plate IX, which does not represent actual discharges above 30 feet on the gauge, and from the prolongation of line 1, Arkansas City–Red River Landing equivalent gauge relations, above 19 feet up to 40 feet, for which distance it makes no approximation to representing actual equivalent gauge readings, but is an assumption of what it is supposed they ought to have been, which has already been discussed in section 4, and has been shown to be an unproven assumption.

As previously stated, if the curves 1 to 10, Plate XI, Red River discharges, had been derived from the things actually observed, and not from assumptions, they would have reproduced the actual discharge curve. The fact that they are widely discrepant at high stages comes mainly from assuming that the curve of equivalent gauge relations, Arkansas City–Red River Landing, Plate V, ought in high stages to be a line which differs very widely from what was actually observed. The changes of plane that these discharge curves Nos. 1 to 10 show give no additional support to the theory of "change of plane." They result mainly from the assumed changes of plane for lines 1 to 5 of equivalent gauge relations, Plate V, Arkansas City–Red River Landing.

It is stated in the paper that these changes of plane are cumulative in going downstream. That necessarily results from the way in which the upper part of curve 1, Plate IX, Red River Landing discharges, 1884–'85, is derived. The upper part of this curve (above 27 feet) is derived from the upper part of curve 1, Arkansas City discharge observations, 1884–'85, Plate IX, and from the upper part of line 1, prolonged, of Arkansas City–Red River Landing, equivalent gauge relations, Plate V. The upper part of the curve 1 at Arkansas City, Plate IX, already erroneously deviates from the observed discharge curve in such a way as to have too small gauge readings. The upper part of line 1 of equivalent gauge relations, Arkansas City–Red River Landing, Plate V, also erroneously deviates from the observations in such a way as to give equivalent gauge readings at Red River less than those observed, and the combination of the two deviations by which the upper part of curve 1, Red River Landing discharge curve, 1884–'85, is obtained adds to the deviations of curve 1 from the actual discharge curve at Arkansas City those due to the process of transfer to Red River Landing. The increasing "changes of plane" in descending the river arise in this way from the method used in determining them, and not from the river itself.

6. The following is a summary of the preceding conclusions with reference to "change of plane" between Arkansas City and Red River Landing:

The change of plane of 5.8 feet at Red River Landing in 1884–'85, deduced in Col. Suter's paper, is unproven. It results almost entirely from the assumption that the curve of equivalent gauge relations, Arkansas City–Red River Landing, 1884–'85, ought to be represented by five parallel straight lines, with an interval between two of them of 5.8 feet, (which is called "change of plane") rather than by the observed curve. No proof is given that these lines must be parallel, and the results can be largely changed by taking them inclined to each other. Hydraulic formulæ show that the curve can not be of parallel straight lines.

The whole curve can be represented, within the limits of errors to be foreseen, by a continuous conic section, so that there is no justification for assuming several straight lines to represent it, or for calling the intervals between them "change of plane."

The discharge curves add nothing to the evidence of change of plane given by the lines assumed to represent the equivalent gauge relations, since their changes of plane result from those previously assumed for the curves of equivalent gauge relations.

The fact that the changes of plane as derived are cumulative in going down the river is not due to the river, but to the assumptions under which they are obtained.

The general reasoning which has been applied to a single case would also be applicable to the other "changes of plane" given in the paper.

The conclusion that there has been an abnormal elevation of the plane of flow at Red River Landing, "which has amounted to as much as 13 feet," results from the erroneous methods used in the appendix to the paper, and this abnormal elevation did not exist.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
President Mississippi River Commission.

APPENDIX 2.

REPORT OF COMMITTEE ON DREDGES.

ST. LOUIS, MO., *July 16, 1892.*

SIR: The committee designated at the November meeting of the Commission to investigate and report on the most suitable means of affording temporary relief to navigation at low-water stages of the river, beg leave to report that they have given the subject very careful consideration and have endeavored to avail themselves of all possible information that would throw any light on the question.

In order to make clear the conclusions reached by the committee, a short discussion of the nature of the problem considered seems necessary.

The bars which obstruct low-water navigation result from the ever-varying action of the water-flow upon the materials which compose the river's bed and upon the immense contributions of similar materials derived from the banks of the main stream and from its various tributaries. This material may all be considered as intermittently in motion, and its position with regard to the main thread of the stream determines the extent and direction of its motion. Thus, where the flow is concentrated the action is the strongest, a deep excavation results, and the material thus removed is pushed on till diminished velocity of flow brings it again to a state of rest. The depths of water thus fairly indicate the relative velocities, and those portions of the bed which receive for the longest period of time the action of the strongest current will, under ordinary circumstances, be the deepest. The well-known tendency of flowing water to take a sinuous course, even when the limiting banks are straight, sets up an inequality of flow within any given section, to which the existence of the bars as we know them is directly traceable. Immediately below the apex of each curvature the concentration of flow is at its maximum, and the deepest water is found here against the concave face of the curve. As we follow along the curved channel we find, where the width is sufficient, that a divergence of flow soon begins. Part of the water still follows the curve, while part of it takes a short cut in the direction of the curve immediately below and opposite the one we are considering. The passage from one curve to another is thus effected in a broad and more or less shallow sheet, instead of in concentrated volume; and on a line normal to this modified flow the material of the bed is more or less undisturbed, and in fact is further reënforced, especially at high stages, by the material scoured from the deeper section or swept through it. This action is repeated at each change of direction with more or less intensity, according to the degree of the curvature and to the width of the bed.

The general result is to build up a series of dam-like bars diagonally across the river bed, and the crests of these bars on the lower Mississippi attain frequently a length of many miles. Their elevation is quite irregular, often under favorable conditions, as in the cases of islands, attaining nearly to the level of the main banks. Where the width is limited, as on the river below Red River Landing, these bar crests are so deeply submerged as to be unnoticeable on the surface, though soundings still reveal their existence, but on all the other portions of the river they are the controlling factor in navigation. Above and below them lie the deep pools, characterized by concentrated flow, narrow section, and small slope; while in crossing from pool to pool a sharp slope, wide section, and small depth are met with. Additional complications are introduced by the immense variation in volume at different stages and by the varied direction of flow which frequently takes place under these conditions. As a rule, it may be stated that the closer the agreement in direction of the high and low water flow the better will be the low-water channel. At very many localities, however, there is much divergence, and at such places low-water navigation is almost invariably bad. As the river falls to the low-water stage channels break through the bar crests at various points, and as the fall of the water exposes more and more of the surface of the bars these channels become better defined and deeper. Eventually they carry the whole discharge from one pool to another. When, as is often the case, these channels are numerous, the discharge is so scattered and its energy so dissipated as to be unable to maintain anywhere a channel of adequate size and depth. Moreover, sand is still moving in considerable quantity, and, as it naturally follows the thread of greatest velocity, it tends in time to choke up the channel which carries the largest discharge. This in turn raises the head of water in the pool above till another channel is broken through, and thus in the course of a season the main channel may shift its position several times and occupy in succession a number of openings through the bar of approximately equal size. It is impossible to predict in advance where the low-water channel will be, nor in the case just mentioned how long it will remain in any one position.

In actual practice the case is much more complicated than has been sketched here, but we have only attempted to outline the principal phenomena as they occur from year to year.

It must be sufficiently obvious that the main difficulty lies in securing a sufficiently concentrated low-water discharge through the great sand deposits left by the high water. Where this concentration occurs naturally, or is brought about by proper regulating works, there is no trouble, but where this is not the case navigation is sure to be more or less impeded.

The duty imposed on this committee is to suggest some means by which these difficulties may be more or less temporarily alleviated. Our answer must necessarily be that, whether for a temporary or a permanent improvement, concentration of low-water flow is the only possible expedient. On small streams the necessary concentration is often successfully secured by cutting off or obstructing all but one channel; but this on a stream like the lower Mississippi would hardly be possible, owing to the time required to effect it, and also to the very great cost. The only other expedient is to enlarge one channel to such an extent that the main body of water will be drawn toward it, thus depleting and cutting off the discharge through the subsidiary channels. To accomplish this purpose a variety of methods have been suggested which will now be briefly recapitulated.

(1) *Movable jetties or wing dams.*—According to this plan it is proposed to anchor or sink converging lines of boats, with leeboards or of closed caissons, on or near the lines of the proposed channel, in order to gather in and direct more water through it. It is further expected that after the required deepening has been effected the plant may be moved successively to other localities. With regard to this scheme your committee would say that, while correct enough in theory, they believe it to be impracticable in actual practice, except possibly in certain special cases. If the caissons, for instance, were once sunk in place, we think it would be impracticable to raise them again in a serviceable condition, and the cost of the plant to fill out the long lines of jetties needed must necessarily be very great.

As regards the other alternative, of barges with leeboards, the great difficulty would lie in keeping the boats in place without obstructing the channel with anchors, and also in keeping the leeboards close to the bottom, failing which they would certainly be inefficient. Moreover, we think, that as in the previous case, the amount of concentration needed would require so extensive a plant as to be prohibitory on the score of cost, if for no other reason.

(2) *Scraping or stirring the bottom.*—This is a favorite scheme, and numberless devices have been brought forward to accomplish it. They all work on the same principle, viz, to stir up the bottom by some mechanical means, as water jets, harrows, plows, etc., trusting and expecting that the sand thus thrown up from the bottom will be carried off by the current. Many of these devices have been faithfully tried and after due trial abandoned. The reason is simple enough: It is a comparatively easy matter to stir up the bottom to any extent, but the current, except under very favorable conditions, is entirely inadequate to carry off the sand thus loosened. This has been the invariable experience when the stage of water has been low enough to make the work a matter of real necessity; and the only success, or partial success, ever attained under these circumstances has been with machines that were calculated to bodily drag away the sand as well as to stir it up. Your committee consider that while in certain special cases some device of this kind might prove to a limited extent useful, yet for general and extensive service, such as is apparently now contemplated by the Commission, they can not possibly be recommended.

(3) *Dredging.*—This is the last alternative, and as it is also the only one which in our opinion holds out the least chance of success, it has received very careful study. In order to clear the ground for the discussion of details, it will be well to give here our ideas as to the scope the work should be given. Taking the fall of 1891 as the type of an exceedingly low stage, it was noted on the trip made by the Commission in November, that the great majority of the crossings which could fairly be called shoal gave a depth of about 8 feet. The very shoal crossings ran down to 5 feet. It is our opinion that no very appreciable benefit would have been conferred unless the depth on these shoaler crossings had been brought up to 8 feet.

If, as is more usually the case, the stage be not so low, a greater depth should be aimed at, the object in all cases being to bring the least depths up to the average as nearly as possible, and to maintain them there. The shoal bars to be operated on extend from Cairo to the mouth of Red River, 765 miles. Last November there were thirty-one crossings having less than 8 feet depth, and as many of these crossings had shoal water for a length of over a mile, it will readily be seen that the contract to be undertaken is by no means a small one. Another point must also be considered. As the dredging proceeds, and especially after an increased flow has been set up, a great influx of sand must be expected. Just how much this will be, how long it will last, whether the current will carry it through, or whether it must be entirely or in part removed by dredging, are questions which in the absence of actual experience it is impossible to answer; but it may be asserted with full confidence that considerably more than the actual visible yardage will require removal. Another point, the

permanence of the dredged channel, also requires consideration. As already mentioned in this report, the naturally formed channels are far from permanent, and it seems unreasonable to expect that artificially formed ones will offer any very different feature in this respect. It seems to your committee that the only chance lies in cutting so deeply as to lower the upper pool materially, and by this means to draw the water away from the minor channels. This will, of course, increase the original work, and even then we deem that it will be the part of wisdom to be prepared for the necessity of repeating the work several times in the course of a season. We should have been very glad to base our estimates on definite figures as to the work to be accomplished, but this has been impossible.

Immediately after receiving our instructions we arranged to have careful surveys made of several of the worst bars, but the sudden rise in the river prevented this, and no opportunity has since been presented. The committee, however, feel that it would be a difficult matter to overestimate this work, and they have approached the subject in that spirit. The time element must figure very largely in a question of this kind; the work to be worth doing at all must be done quickly. In our opinion not more than two weeks should be allowed for opening a channel as far south as may be necessary. Such an undertaking at once precludes the use of any of the common types of bucket or elevator dredges and throws us back on suction or pumping dredges as alone possessing the elements of speed and capacity required. Of these there are three types, varying with the method of disposing of the spoil. The self-loading dredges used on river-mouth and harbor bars, and of which the *Bayley* may be mentioned as a type, are out of the question here, as their draft when loaded would be too great. To use dump scows in work of this magnitude, while not impossible, would involve many delays and difficulties and would require a very considerable increase in the plant; as under these circumstances a towboat and a large fleet of dump scows would be absolutely necessary. The method of pumping the spoil through long floating pipes to deep holes or points outside the limits of the channel seems to us, on the whole, the one best adapted to this special case. The pumping machinery should be mounted on a steamer of reasonably light draft and fair power, so as to insure speedy travel from place to place and ample capacity while at work to supply steam power to the pumps used in dredging. Both in first cost, in maintenance, and in running expenses a large plant will cost much less than several small ones of the same aggregate capacity. We should, therefore, prefer a vessel of as large size as can be handled with certainty and facility, placing on this vessel as large pumps as the draft of water and the extent of the possible steam supply will justify.

Reasoning from such imperfect data as we have, the actual yardage requiring removal may be placed at from 500,000 to 1,000,000 cubic yards. These figures are liable to be increased to an uncertain extent by the causes already adverted to, but taking them as the basis of estimate and two weeks as the longest allowance of time available, it will be seen that the removal of from 36,000 to 72,000 cubic yards per day will be necessary. This will probably require at least two and possibly three outfits. There is a good deal of uncertainty regarding the proportion of sand to water which can be lifted by pumping, but 10 per cent seems to be about the lowest limit, while 20 and 30 per cent are not impossible. This question can only be settled by direct experiment. A pump discharge of 50,000 gallons per minute would, with the smaller percentage mentioned, give a capacity of about 1,500 cubic yards per hour. We further think that ten hours out of the twenty-four would be a fair average of the working time, allowing for all incidental delays due to fog, bad weather, and repairs to machinery and the loss of time involved in moving from place to place. This would make the daily capacity from 15,000 to 45,000 cubic yards, according to the percentage assumed. The power required to run the pumps would be between 300 and 400 I. H. P., and the total power provided for both boat and pumps should be about 600 I. H. P. The boat's engines should be proportioned to utilize the entire power while in transit from place to place, and a coal supply sufficient for at least a week's work should be carried on board. The full loaded draft of the boat should not exceed 4 feet.

The best method of working the dredge is a matter of great importance, but one upon which we hardly feel competent to make at present any definite recommendation. If the dredge while at work is to be kept stationary by anchors or other appliances or moved slowly by capstans along the line of dredging, the whole operation will be much simplified and will not vary materially from ordinary work of this nature. There are, however, objections to this method, which may prove serious in practice. The intrusion into the main channel of a large boat, with the necessary lines and anchors, would render the passage of boats dangerous, both for themselves and for the dredging plant, and would probably necessitate the stoppage of work and removal of the dredge whenever a steamer desired to cross the bar. If a dredge could be used which was maneuvered while at work entirely by its own power, uncomplicated by lines, anchors, and similar appliances, the difficulties above alluded

to would be avoided, as such a boat could more readily be dropped out of the way of passing vessels. In such a design the use of drags on the suction pipes of a nature similar to those of the dredges used in the New York Harbor would probably be necessary, and without question the work of raising the solid material would be slower and more uncertain than by the other method, while breakages and other interruptions of work would be more frequent. The disposition of the spoil would also be more difficult. As internal receptacles are not possible, dump scows would probably be required.

There is a possibility that floating pipes might be used, or long suspended pipes projecting over the boat's sides to beyond the limits of the dredged channel, but there would be many difficulties involved in either method. None of the points adverted to can be definitely settled until by direct experiment it shall have been determined just what work is likely to be required and what conditions in a design are the most desirable. Such experiments should be made on a fairly large scale, so as to bring the whole question to a definite test; yet at the same time we do not consider it either advisable or necessary that the Commission should incur large expenditures, which might prove entirely useless. We would, therefore, recommend that the Commission procure one or two pumps of approved pattern and of a capacity of say 20,000 to 25,000 gallons per minute each. Let these pumps each be mounted in a temporary fashion on barges, old steamboat hulls, or any similar cheap structure, and let the work be done at low water in as systematic and thorough a manner as possible, so as to develop fully all the points upon which doubt now exists. With such information available, a design for permanent work can be prepared with some confidence as to its value and efficiency. If successful in operation these pumps and other machinery could probably be used in the permanent design, but in any case the amount involved would not be excessive, and would undoubtedly result in decided economy in the long run. Of course in the experiments here recommended a self-propelling machine is not contemplated, and a towboat, with possibly some dump scows, should be provided for each dredge.

Respectfully submitted.

CHAS. R. SUTER,
Lieut. Col. of Engineers.
HENRY FLAD,
Civil Engineer.

Gen. C. B. COMSTOCK,
President Mississippi River Commission.

APPENDIX 3.

REPORT OF CAPT. CARL F. PALFREY, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

ST. LOUIS, MO., *June 15, 1893.*

GENERAL: I have the honor to present the following report of operations under my charge as secretary Mississippi River Commission and assistant to construction committee from May 31, 1892, to May 31, 1893.

These works are carried on under the following allotments from the appropriations approved September 19, 1890, and March 3, 1891, made by the Commission and approved by the honorable the Secretary of War:

First. "Mississippi River Commission," applicable to salaries of three Commissioners, to expenses of offices of president and secretary, and to expenses of meetings and inspections of Commission.

Second. "Surveys, gauges, and observations," applicable to the general survey of the river, to collection and office reduction of physical data, and to general examinations and computations not confined to any one district.

Third. "General service," applicable to supply of stone, maintenance of plant, and general aid to works in the districts.

The small balances from earlier appropriations which appear in the financial statement are set off by outstanding liabilities for telegrams, which can not under existing orders be adjusted.

MISSISSIPPI RIVER COMMISSION.

The Commission has held four sessions during the period reported: At New York City, June 22 and August 2–5; on board steamer *Mississippi* from St. Louis, November 5, to New Orleans, November 19, 1892; and on board steamer *J. G. Barnard*, loaned for the purpose by Maj. A. Mackenzie, Corps of Engineers, from St. Louis, May 6, to New Orleans, May 11, 1893.

On January 16, about 9:30 a. m., the upper works of the steamer *Mississippi*, laid up at Paducah, Ky., were destroyed by fire, probably caused by a spark escaped from the breeching of the "nigger" boiler, in which steam was kept up for setting lines as the water level changed.

The fire was first seen on the under side of the boiler deck, and quickly burned through the floor of the forward cabin a little forward of the steam box of the main boilers.

The fires of the "nigger" boiler had just been drawn, and the steam pressure was only 20 pounds, insufficient for throwing water from the steamer's hose.

A barge was laid up just outside the steamer *Mississippi*, and the steamer *Eagle* was at the time lying outside the barge, taking on lumber from the shore, her deck crew crossing the decks of the *Mississippi* and the barge. The *Eagle* endeavored to assist, but her hose was small, and before it could be brought into play the flames had too great headway for it to be effective and for the position of the barge and the *Eagle* to be safe. The ice in the river, from ¼ to ⅜ inch thick, rendered the buckets of little or no use. The alarm was sent to the fire department of Paducah, and was answered but the first supply of hose was insufficient, and by the time a second arrived the only service to be rendered was the quenching of some burning coal in the hold.

The progress of the fire was so rapid that little of the boat's property was saved. The two watchmen and the wife and child of one of them saved no clothing but what they had on. Some blocks in the forward hold and some blacksmith's tools which passed through the fire, a small quantity of bedding thrown on board the barge, a tin box of plated forks and spoons, badly damaged by fire, and a small iron safe, with one castor broken by fall, are all that was recovered.

Telegraphic report reached me at 2 p. m. I reached Paducah a little after midnight, and saw the wreck next morning.

The débris capable of holding fire had already been cleared away. The main deck was deeply charred all over and burned through in several places. The main boilers had still their cover of plaster and asbestos and showed no trace of injury. The main cylinders and the doctor, except its heating box, also appeared uninjured; the paint was not burned entirely off. The cylinder beams, iron "I" beams with castings of plate, were true to the eye, and showed no injury except that one plate of the casing of one of them was slightly warped. The wheel was uninjured.

Every indication was that a light offshore wind, or the draft over the bank caused by the fire, carried the flames across the boat. On the shore side the smoke stack, though fallen, appeared unscorched; that on the offside was collapsed. In the engine room two cans of oil standing near the cylinder beam on the shore side were not burned; on the offside one plate of the beam casing was slightly warped. The wheel was hardly charred at all; the barge lying alongside was badly so.

The moorings of wire cable probably saved the steel hull. The ice in the river was running rapidly; had the hull drifted beyond reach of hose from shore the coal stored therein would, in its burning, have warped the plates and bulkheads. It was promptly extinguished, and I can see no injury to the hull.

The sum of $25,000 was allotted for rebuilding the steamer *Mississippi*. She has been towed to Carondelet, hauled out, and redecked. Repairs of machinery and rebuilding of upper works are in progress.

SURVEYS, GAUGES, AND OBSERVATIONS.

Fieldwork under this allotment has been nearly continuous during the period reported. The triangulation party in the field, on board steamer *Patrol* on May 31, 1892, closed their work about 9 miles below Dubuque, Iowa, on August 26; started down the river on the same date, filled in, en route, some work prevented by high water, and reached Quincy, Ill., August 30. August 31 was occupied in preparing quarter boat *Illinois* for occupancy and towing to Hannibal, Mo., where topographical work began. This work was closed at head of Des Moines Rapids on November 10, the quarter boat was laid up in the canal, and *Patrol* reported at St. Louis on November 14. On November 17 she left St. Louis, carrying instruments and outfit for surveys below Donaldsonville, and having on board Assistant Engineer Ockerson, under orders for inspection of gauges; this inspection was closed on December 15. On December 8 the assistant engineers of the triangulation and stone-line party joined at Donaldsonville and carried work to New Orleans by January 13. On January 12 the assistant engineers, recorders, and rodmen of precise-level party joined at Kennerville, and all proceeded, January 17, to Head of Passes for work thence to New Orleans. This work was closed at New Orleans on March 15. En route, returning, the boat's crew replaced the bulletin at Arkansas City, destroyed by fire, by one of new type with iron frame.

March 27 Assistant Engineer Paige rejoined at Cairo for connection of Belmont

gauge with previous benches. The *Patrol* reported at St. Louis April 4, and after slight refitting, boiler inspected, and delay by storm, left for Keokuk on April 8. En route bench marks of stone lines 81, 82, 83 situate near a railroad embankment soon to be enlarged, were relocated by Assistant Engineer French. The *Patrol* reached Keokuk on April 15 and was hauled out for repairs on April 18. The trip on the lower river had developed some weakness which, in prospect of another season there next winter, required attention. On May 2 Assistant Engineers Morrow and French left for work in the base line and closing line of last season's triangulation and for reconnoissance for that of the coming season. Repairs of *Patrol* were completed on May 17, and she reported at Dubuque on May 20 with party and equipment for triangulation.

Secondary Triangulation, and Stone-lines—On May 31, 1892, a party in the field since April 25, consisting of Assistant Engineer Charles W. Stewart, in charge, Assistant Engineers A. T. Morrow and George H. French, Recorders C. L. Ockerson, O. N. Axtell, and M. I. Powers, with boat's crew and working party of T. C. Hockridge, master and foreman, and 23 men, had carried this work to Fairport, Iowa, having then occupied 16 triangulation stations, marked 18 triangulation points, and 12 stone lines, completed work covering about 22 miles of river.

This party closed its season's field work on August 26 at a point about 9 miles below Dubuque, started down river the same night, completed en route some stone-line work near Muscatine, Iowa, left undone because of high water. Assistant Engineer Stewart turned over boat and party at Quincy on August 30 to Assistant Engineer Morrow, in charge of topographical work, and reported at office for computations and report.

Instructions for this work as to triangulation, printed in Annual Report 1891, pp. 3474–3476, as to stone lines, formerly placed by topographical party, in same report, pp. 3481–3485.

The season's work extends from Port Louisa, Iowa, to near Galena, Ill., covering about 138 miles of river by 72 triangles, and closing on a Coast Survey triangle-side, Horseshoe–Sinsinnaway; 1 base line of about 1 mile was measured along railroad track near Rapids City, Ill.; 41 stone lines, Nos. 136–176, were marked by 118 bench marks of tile and pipe.

The chain from New Boston base (9 miles below Port Louisa), measured in 1891, to Rapids City base is of 39 triangles, has a length by river of 68 miles and an axial length of 59 miles. The chain from Rapids City base to close is of 36 triangles, has a length by river of 79 miles and an axial length of 70 miles. The average error of closure of the 72 triangles of this season was 1″.88; 34 are large, with average error 2″.22 and greatest error 5″.82; 37 are small, with average error 1″.62 and greatest error 5″.21; 1 has no error.

The base at Rapids City was measured twice, with discrepancy of two measurements, 1:594917. The two observations for azimuth by Assistant Engineer Stewart were too widely discrepant and were rejected. May 9 and 11, 1893, observations for azimuth were made by Assistant Engineer Morrow, which were accepted. The results are as follows:

Computed length, 1,604.829 meters; measured length, 1,604.756 meters; discrepancy, 1:21807. Computed azimuth, 69°03′ 52″.2; observed azimuth, 69°03′ 47″.5; discrepancy, 4″.7.

The season's work was not closed upon a base line, the ground being unfavorable, though the customary interval was fully covered. It was closed by Assistant Engineer Stewart on what he supposed to be the side, Sinsinnawa–Horseshoe Mound, in the triangulation of the U. S. Coast and Geodetic Survey across Wisconsin in 1881. The descriptions received from the U. S. Coast and Geodetic Survey render it questionable whether he occupied the station Horseshoe Mound, and the coördinates furnished did not show this line as a side of a completed triangle.

On the reporting of the *Patrol* with full party, May 20, 1893, Assistant Engineer Morrow proceeded to occupy Stewarts Station Horseshoe, and the U. S. Coast and Geodetic Survey stations Sinsinnawa and Gratiots Grove (which were recognized beyond question), and thus joined the Mississippi River Commission work with that of the U. S. Coast and Geodetic Survey on the line Sinsinnawa–Gratiots Grove, a side of a completed triangle in both systems.

The regular triangulation has been carried on, occupying 8 stations and closing 5 triangles, with average error of closure, by field computation, of 1″.75. Favorable location of a base line has been selected; it will be measured in June.

Report of Assistant Engineer Stewart on the fieldwork under his charge, together with plat of triangulation and descriptions and geographical positions of stations as far as Rapids City, prepared in this office, is appended, marked A.

Topography and hydrography.—On September 1 a party, consisting of Assistant Engineer A. T. Morrow, in charge, with Assistant Engineers W. G. Comber, George H. French, E. L. Harman, H. Dunaway, and E. J. Thomas, and Recorders C. L. Ockerson and O. N. Axtell on topography, Recorders A. O. Wheeler and T. G. Ray on ordinary levels, T. C. Hockridge (also master of *Patrol*) and L. D. Cabanne on

hydrography, M. I. Powers and H. C. Winchell on computation and platting, with boat crew and working party of forty-nine men, assembled at Hannibal, Mo.

The working season was from September 1 to November 10. The reach covered is from stone line 94, near the railroad bridge at Hannibal, Mo., to stone line 114, near head of Des Moines Rapids, 10 miles above Keokuk, Iowa, a distance of about 69 miles by river. The belt surveyed in this section is broader than the average, and includes a large amount of shore line (sloughs and islands) per mile of river. Up to and including No. 111 stone lines were placed by the topographical party. The season's work overlaps 9 miles by river upon the triangulation of 1891, in connection with which the stone lines were placed. The weather was favorable for fieldwork, and field plats were carried little beyond the instrumental lines necessary for check. Field plats were made on tracing linen for direct transfer to detail charts. (The original platting is slower; the time so lost is fully made up in the transfer, with gain of accuracy.) During work in the overflowed lowlands there was considerable sickness in the party; by temporary enlargement of the working force the work was carried on without material delay.

The instructions for this work are given in Annual Report 1891, pp. 3481-3485.

The tertiary triangulation occupied 143 stations and closed on 11 measured bases, 1 side of secondary triangulation for distance and 10 for azimuth.

Average error of closing, 1 in 9,652.

Lines of ordinary levels on both banks, with crossings near each stone line, checked each other with a greatest discrepancy of 0.145 foot, average 0.101 foot. These lines were checked at 12 points upon lines of precise levels run in 1881, with discrepancies ranging from 0.00 to 0.17 foot.

Twenty-four high-water marks of dates 1851 to 1892, whose history and accuracy appeared well established, were connected.

Soundings were taken on 402 sections, also in continuous line where channel was evident, and in several trial lines over shallows and divided channels, a total number of 25,490 soundings located by 10,674 sextant angles.

Report of Assistant Engineer Morrow is appended, marked B.

Triangulation, stone lines, and precise levels from Donaldsonville to Head of Passes.—For the extension of the surveys under the Commission from Donaldsonville, La. (where they were closed in 1883), a party took the field at that point on December 8 to make such triangulation as might prove necessary in a region already triangulated by the U. S. Coast and Geodetic Survey, and to mark the stone lines. As its work neared New Orleans it was joined by a precise level party, and both began work at the Head of Passes and carried their work to a junction with the triangulation above and the line of precise levels run from Biloxi in 1882. The work was thus broken to determine at once the feasibility of running precise levels on the soft lowlands, and to reach the levees before the rise of the river. Both works were closed at New Orleans on March 15, the precise levels connecting with the old line at three points.

Descriptions of triangulation stations and located points were furnished by the Coast and Geodetic Survey. Enough of them were found to render secondary triangulation unnecessary. In long reaches the tertiary triangulation was checked by frequent base lines and by distance measured by chain or tape as a check, though not used in computation as bases. The monuments are located to within the possibility of delineation on scale 1:10000. Stone lines besides the left bank section of No. 188, near Donaldsonville, were marked by 198 tile and pipe bench marks.

By exercising care in the placing of instrument and rods the precise levels have been kept well up to the average of this work. To test the accuracy of bench marks set in such soil advantage was taken of a delay by wind at Fort Jackson while en route from New Orleans to Head of Passes. On January 18 a bench mark was set in selected unfavorable ground, such that water was baled out of the pit before setting the tile, and carefully connected with a temporary bench on a tree. On February 3 and 5, when the line reached Fort Jackson, it was again connected. The results in the three dates differ only in the tenths of millimeters, and the mean of all is the same as the first determination.

This experimental bench mark gave a curious evidence of the elasticity of the soil of the Delta. The tile was well settled in place and its elevation taken before filling the pit. After filling the elevation was again taken through the pipe, and it was found to have settled 4.8 millimeters. After releveling, on February 3, the tile was uncovered and rose 3.8 millimeters. On refilling the pit the same settlement took place.

The time interval (January 18 to February 3) given in this experiment was all that the conditions of the work permitted. The results appear to show that these bench marks in soft springy ground are good if there is no disturbance of the ground near them, but may be affected by a turning up of the soil within a distance which would elsewhere be regarded as safe. The traditions of the former and present relations to the ground and water levels of a house near Cubitts Gap, would indicate that the

soil of the Delta is raised by deposit of sediment and lowered by consolidation. It is possible that a future releveling of this line from the Metairie Ridge may determine this point.

Report of Assistant Engineer Morrow on the field work of this party, with descriptions and geographical positions of stone-line bench marks, is appended, marked C; also report of Assistant Engineer Paige on precise level work, with descriptions and elevations of permanent bench marks, marked D.

The present status of the surveys is as follows:

Triangulation and stone lines completed from Head of Passes to a little above Dubuque, Iowa; extension northward in progress.

Precise levels completed from Head of Passes to St. Paul, with side lines New Orleans-Biloxi, Savannah-Chicago, and St. Paul-Duluth; no extension projected.

Topography and hydrography complete from Donaldsonville, La., to head of Des Moines Rapids; extension northward projected for summer and autumn of 1893; completion from Donaldsonville to Head of Passes projected for winter of 1893–'94.

Manuscript charts, etc.—Detail charts, scale 1:10000: On May 31, 1892, these charts were completed to include No. 121, extending to stone line, 74.3 miles above Cap au Gris, with three in progress extending to midway between stone lines 85 and 86. They are now completed, except final retouching, to include No. 130, extending to just below Quincy, Ill., with six in progress, nearly completed, extending to stone line 114, at head of Des Moines Rapids, covering the field work of 1892.

In connection with these the sounding chart, serving also as index chart, is completed to same line. The office force for this work consists of the field topographers. All surveys and mapping have been under the direction of Assistant Engineer Ockerson.

Topographical maps, scale, 1 inch: 1 mile: On May 31, 1892, these maps were completed to Water Works, St. Louis (195 miles above Cairo), with one sheet in progress extending to mouth of Missouri River (207 miles above Cairo).

One has been redrawn, and two partly redrawn for better arrangement and execution. They are now completed to just below Grafton, Ill., 232 miles above Cairo (nine maps, numbered 101–109), with one in progress, extending to 255 miles above Cairo.

This work is in the hands of Mr. C. W. Clark.

Published charts and maps.—The charts and maps published by the Commission are the following. Except official issues under resolution of the Commission they are, in accordance with law, sold at the prices annexed:

	Cents.
Alluvial valley (scale, 1 inch: 5 miles) (completed) .....per sheet..	10
Alluvial valley (scale, 1 inch: 5 miles) .....per set (8 sheets)..	40
Mississippi River (scale, 1: 20000) (in progress).....per sheet..	20
Mississippi River below Cairo (scale, 1 inch: 1 mile) (completed) .....do....	5
Mississippi River above Cairo (scale, 1 inch: 1 mile) (in preparation).	

On May 31, 1892, of the charts, scale 1:20000, sixty-six sheets, extending from Cairo to Donaldsonville (numbered southward from 3 to 69), were published, and fourteen sheets, extending from Cairo to the southern limit of Carondelet (numbered northward from 101 to 114).

For the southward series, index charts (numbered 1 and 2) have been published, completing that series as far as surveys have been made. Of the northward series Nos. 115, 116, extending to mouth of Missouri River, have been published; final proofs of Nos. 117, 118, extending to just above Grafton, Ill., have been received.

On May 31, 1892, of the inch-mile series above Cairo, five maps were in hands of the printer. This printer failed utterly to produce satisfactory work. Eight maps, extending to mouth of Missouri River, are now in the hands of the printer. Satisfactory proofs have been received of five of them. The progress of publication has hitherto, for various reasons, lagged far behind that of preparation for it. With reasonable promptness on the part of the printer the field work of 1892 will all be published before the end of 1893.

The gauges maintained by the Commission have been sometimes under charge of the secretary and sometimes under that of the district officers. Few of them are of permanent construction, and some, owing to caving banks, have not been permanent in location. To determine their present condition and to put their location on record as accurately as the nature of the river bank leaves possible, an inspection was made during low water by Assistant Engineer J. A. Ockerson. His report, with plats, is appended, marked E.

The records for 1892 of gauges under the Commission, as well as of certain others under Majs. Mackenzie and Miller and Capts. Willard and Taber, Corps of Engineers, under the Weather Bureau, and of the Cincinnati Water Works, have been received, tabulated, and printed in pamphlet form, together with descriptions of gauges and bench marks. (Issued March 23.)

A table of high and low water, in extension of that published in Annual Report, 1891, pp. 3555-3575, is appended, marked F.

By direction of the president Mississippi River Commission the following tables have been prepared:

1. Showing, for certain selected stations and for the years 1872-'92 (except as noted in tables), the highest, lowest, mean highest, and mean lowest stages. (Appended, marked G.)

2. Showing, for certain selected stations, and for the years 1872-'92 (except as noted in tables), the mean number of days in which the stage above extreme low water was in successive intervals of 5 and 10 feet. (Appended, marked H). Since and including August, 1892, all gauges and records received weekly or monthly have been tabulated monthly and sent to Commissioners and district officers.

The office hydrographs have been kept up to date.

The discharge observations of 1892 have been recomputed and results tabulated and printed in pamphlet form. (Issued May 27.) Copy is appended, marked I.

This work has been under charge of Assistant Engineer Kivas Tully, assisted by Messrs. George H. Johnson and C. A. Bonfils.

Miscellaneous.—The exhibit of this office has been prepared and shipped to the Columbian Exposition. It consists of 1 atlas detail charts, mounted and bound; 1 atlas inch-mile maps, mounted and bound; 1 atlas survey of caving banks, blue prints; 1 atlas annual hydrographs, containing hydrographs, 1873-'92; 1 set of borings, mounted in glass tubes; 1 set of topographical sign printing apparatus (furnished by Assistant Engineer Ockerson); 1 set of "Stages," and 1 set "Discharge Observations."

A study has been made of early maps of the Mississippi River below Cairo in comparison with those published by the Commission. The maps studied are those of Lieut. Ross, Thirty-fourth Regiment, from observations taken on a journey in the latter part of the year 1765 (London, 1776); of Capt. Phillip Pitman, from observations extending probaby from 1765 to 1768 (London, 1770); and of Brig. Gen. Victor Collot, from a journey September 16-October 26, 1796 (Paris, 1826). Report of method and results with tracings of the maps, and meander lines platted for comparison, is appended, marked K.

For the privilege of tracing Ross's map I am indebted to the librarian of the Missouri Historical Society; for that of Pitman's, to Col. George E. Leighton, of St. Louis. Collot's is in my possession.

GENERAL SERVICE.

On May 31, 1892, the general service was engaged in the repair of barges and in towing stone from Apple Creek Quarry to works in the first and second districts.

On June 22 the commission, in session at New York, directed that the general service be abolished as soon as practicable after June 30, that its property be distributed to the works of the secretary and the first, second, and third districts, and that the officers in charge of those works make the distribution.

These officers met at Memphis on July 16, and assigned to the secretary the furniture in his office and the steamer *Mississippi* with outfit; to the first and second districts, the steamer *Minnetonka* with outfit, the camel docks, and one-half the barges and working tools; to the third district, the steamers *Etheridge* and *Vedette* with outfit, and one-half the barges and working tools.

In view of the importance to the first district of the repair of barges and the stone supply, this work, with control of all property, was turned over to Capt. S. W. Roessler, in charge of that district, the formal transfer of property to be completed when the requirements of this work permitted. It was completed at the end of December.

Stone supply.—The season of 1892 extended from February 21, when on notice that the barges in this district were free, the *Minnetonka* was sent out to collect them to July 20, when the work was turned over to Capt. Roessler.

The expenditures and results are tabulated below, the cost of towing, as in former reports, includes all running expenses of steamers, but not repairs others than those made en route, nor interest on value of plant.

Statement of cost of towing stone to first district, by the general service, February 21 to July 20, 1892.

Total running expenses of steamers		$12,663.58
Less applied to third district, returning empties		5,740.24
		6,923.34
6,408,437 yard miles, at $0.00107		6,923.34

Cost of stone on barges.

		Cents.
At quarry	per cubic yard	62.50
At Daniels Point	do	87.34
At Ashport	do	87.34
At Keyes Point	do	87.34+

The general service was organized in 1882, having for its functions the purchase, construction, and repair of plant, and the purchase and delivery of general supplies and materials for the districts. Of later years the stone supply and repair of plant has been almost its only service. Its plant has been held in the districts whenever required for the works, and collected by it when not so required for repair and for stone towing. It has had no permanent location and at no time the control, by purchase or lease, of any water front. Up to 1889 it was a separate charge; since that year it has been under the secretary.

Its expenditures, 1882–'92, are as follows:

Running expense of steamers, charter, etc	$358,443.89
Repairs and care of plant (labor and material)	315,121.52
Plant and outfit	189,773.03
Inspection administration and office	102,243.88
Purchase of stone	20,151.38
Raising sunken barges and property	3,219.33
Medical attendance	403.40
Miscellaneous	289.90
Total	989,646.33

"Running expense of steamers" covers the delivering in the districts of 386,788 cubic yards of stone, about 10,000 tons of coal, and about 4,000 tons of general supplies, that of the floating plant built above Cairo on Mississippi and Ohio rivers, as well as of its own plant, when required, and its collection after such service, with incidentally some moving of plant, and, in emergency, direct aid in construction in the districts.

"Repair and care of plant" includes that of the general service, that of fifty-eight barges purchased from allotment for New Madrid, of thirty barges borrowed for the Mississippi River Commission in use from May, 1884, to March, 1885, and of some belonging to the districts.

"Plant and outfit" includes part payment for building and fitting out steamer *Mississippi*, purchase of steamers *Minnetonka*, *Ethcridge*, and *Vedette* with outfit, building thirty barges, three camel docks, and upper works to make a store boat of a second hand coal barge, also the necessary provision of small boats and working tools.

The office expenses, as distinct from inspection and administration, have been of late years an allotted five-twelfths of the expenses of the combined office; in the early years those of the separate office included the printing under the commission.

"Purchase of stone" includes only that directly paid for by the general service; most of that actually purchased was paid for by the district officers.

The expenditures have been distributed among the districts and the several titles of allotment, as shown in the detailed statements of expended and current allotments.

TONNAGE AND TRAFFIC.

The through traffic of the lower Mississippi River comes from the upper Mississippi and Missouri rivers and northern and northwestern railroads (reshipped from St. Louis) and from ports on the Ohio River.

From the northern rivers and railroads the most important shipment is of grain in bulk for export to European ports, much of which is sold in Europe before shipment. This traffic, entirely in the hands of the St. Louis and Mississippi Valley Transportation Company, aggregated as follows:

Corn	bushels	5,763,187
Wheat	do	6,662,799
Oats	do	36,857
Total	tons	365,859

The principal items of miscellaneous freight carried down by this line (total 42,301 tons) are white lead, flour, grain in sacks (for domestic trade), and meat products.

The principal items of return freight (total, 40,425 tons) are imported cement and rice and native lumber. Detailed statements of the "Shipments of bulk grain," and of "Shipments by N. O. boats and barges," taken from report of St. Louis Merchants' Exchange, and of return freights, furnished by the secretary of the company, are contained in commercial statistics appended, marked L.

The traffic from northern rivers and railroads to way ports (also reshipped at St. Louis) is in the hands of the "Anchor Line."

Detailed statement of it is contained in the "Shipments by Memphis, Vicksburg, and Natchez boats," taken from report of St. Louis Merchants Exchange in Appendix L.

On the estimate of this company 1 per cent is deducted for traffic between St. Louis and Cairo and 40 per cent added for return freights, giving a total of 106,813 tons.

All of the above traffic was seriously interfered with by the extreme range and the long duration of both the high and low waters. The former cut off the communication with the grain elevators at St. Louis and with many way landings, affecting both heavy and light traffic. The low water, while affecting both, tells more seriously on the heavy traffic. This is shown by the records of two trips, the best and the worst of 1892. On March 5, 4 p. m., the steamer *Hoxie* left Cairo with six barges, loaded to 8 feet 8 inches, carrying 8,843 tons of freight. Reached New Orleans March 12, 12 m. Left New Orleans March 13, 6 a. m., with six barges, carrying 790 tons of freight. Reached Cairo March 24, 2 a. m. Round trip time, and full steamer service, seventeen days sixteen hours. On November 5, 5 a. m., the steamer *Clark* left Cairo with six barges, loaded to 5 feet 1 inch, carrying 4,008 tons of freight. Had en route eight days twenty-one hours of service of an auxiliary steamer. Reached New Orleans November 19, 8 a. m. Left New Orleans November 20, 4 a. m., with six barges, carrying 1,850 tons of freight. Reached Cairo December 1, 9 a. m. Round trip time, twenty-five days, eight hours; total steamer service, thirty-four days, five hours.

The secretary of the company writes: "At low stage it is almost impossible to tow more than three barges at once between Cairo and points as low down as Helena, the channels being so close as to forbid of tows of greater width; hence we are compelled to use auxiliary or helping steamers for a part of the journey."

The *Hoxie*, the *Clark*, and the auxiliary steamer are all of the first class, representing substantially the same expense and working power. The coal expenditure is slightly less in low-water towing; the breaking of lines and wear of plant much greater. In counting the expense as proportional to the hours of steamer service I consider the low-water towing to be treated with favor. The upstream freight is not of such quantity as to make draft important. In counting the freight carried I consider the downstream freights alone to give the ratio really in question. On this analysis the cost per ton of towing on draft 5 feet 1 inch is 4.279 times that of towing on draft 8 feet 8 inches.

Taking the trip of the *Clark* as the worst of the season, and assuming a perfect combination of trips, the auxiliary steamer, working from Cairo to Helena, might give aid to three steamers of the regular line while the first was completing its round trip, thus securing from four steamers, including the auxiliary, the full work of three in the regular line. Compounding this ratio of steamers required, that of the downstream freights and that of the round trip times, the efficiency of steamers on draft 8 feet 8 inches is 4.217 times that on draft 5 feet 1 inch.

The low water usually occurs at a time when St. Louis elevators are full of grain, and certainty and promptness of transportation is important.

The Cherokee Packet Company, plying from St. Louis to Memphis, carries downstream freights of general merchandise, upstream freights of lumber, grain, and hay. Deducting deliveries above Cairo, their agent estimates the downstream freight at 21,600 tons; upstream, 12,500 tons; total, 34,100 tons.

The principal shipments from the Ohio River are of coal from Pittsburg and general merchandise from Cincinnati; the principal return freights are of sugar, molasses, and cotton products.

The secretary of the Pittsburg Coal Exchange has furnished me a statement of shipments of coal delivered in successive reaches of the river, which he has compiled from statements of shippers, the records of the exchange not containing the information in this form. The total of these shipments is 1,850,060 tons. No freight is brought back, and many of the barges are sold with the coal. (Copy in Appendix L.)

The superintendent of the Cincinnati Chamber of Commerce has furnished me with a statement of the traffic with the Lower Mississippi from that port, also made up from special inquiry, classified only as above and below Memphis. The downstream shipments are of general merchandise; the upstream are mainly sugar and molasses and cotton products. They aggregate, downstream, 28,071 tons, upstream, 27,811 tons; total, 55,882 tons. (Copy in Appendix L.)

The above comprises nearly all the through traffic on the Lower Mississippi; there remain that of a few small steamers and some small way traffic of the through steamers, of which little or no formal record is kept, and of which no trustworthy estimate is accessible to me. From the information furnished I summarize as follows:

Downstream: From the northern rivers, 499,118 tons; from the Ohio, 1,878,071 tons; total, 2,377,189 tons.

Upstream: To the north, 90,380 tons; to the Ohio, 27,811 tons; total, 118,191 tons. Aggregate, 2,495,380 tons, of which about three-fourths are carried over the whole distance Cairo to New Orleans.

As the commercial sections most nearly corresponding to the engineer districts, I take the following: First, from Cairo to and including Memphis; second, from Memphis to and including White River; third, from White River to and including Vicksburg; fourth, from Vicksburg to and including New Orleans.

*The traffic by the Anchor Line of steamers is, on the estimate of the company, apportioned, one-fourth to Memphis, one-half to Vicksburg, and one-fourth to Natchez.

This gives the through-freight traffic of the districts as follows:

First. Down, 2,377,189 tons; up, 118,191 tons; total, 2,495,380 tons; of which 2,143,480 tons were in transit, 351,900 delivered or shipped in the district.

Second. Down, 2,063,571 tons; up, 79,909 tons; total, 2,143,480 tons; of which 2,083,480 tons were in transit, 60,000 tons delivered in the district.

Third. Down, 2,003,571 tons; up, 79,909 tons; total, 2,083,480 tons; of which 1,882,325 tons were in transit, 201,157 tons delivered or shipped in the district.

Fourth. Down, 1,821,292 tons; up, 61,031 tons; total, 1,882,323 tons; all delivered or shipped in the district.

I have tabulated the above so as to show, for each district, the source or destination of the above traffic, with the amounts in transit and those delivered downstream or shipped upstream, and the local traffic from information received from the district officers. It is the first statement in Appendix L.

Financial statements for May, detailed and consolidated statements up to May 31, statement of maps issued, list of civilian engineers, and approximate value of plant, are appended.

I have the honor to be, very respectfully, your obedient servant,

CARL F. PALFREY,
Captain of Engineers.

Gen. C. B. COMSTOCK,
President Mississippi River Commission.

Secretary's office—Financial statements for the month ending May 31, 1893.

	Mississippi River Commission act Oct. 2, 1888.	Survey of Mississippi River, act Aug. 11, 1888.	Improving Mississippi River; surveys, gauges, and observations.	Improving Mississippi River; Mississippi River Commission.	Improving Mississippi River; rebuilding steamer Mississippi.	Total.	Works above Cairo, act July 5, 1884.
Balance unexpended at end of last fiscal year	$138.26	$7.08	$44,206.71	$35,560.97	.....	$79,913.02	$8,600.00
Appropriated and allotted during current fiscal year	.....	.....	.....	.....	.....	.....	.....
Gained by transfer during current fiscal year	.....	.....	46,345.33	.....	$25,000.00	71,345.33	.....
Lost by transfer during current fiscal year	.....	.....	.....	.....	.....	.....	.....
Total available	138.26	7.08	90,552.04	35,560.97	25,000.00	151,258.35	8,600.00
Expended during current fiscal year	.....	.....	*59,860.70	25,610.36	649.64	86,120.70	.....
Refunded during current fiscal year	.....	.....	.....	.....	.....	.....	.....
Total disposed of	.....	.....	59,860.70	25,610.36	649.64	86,120.70	.....
Balance unexpended	138.26	7.08	30,691.34	9,950.61	24,350.36	65,137.65	.....
In treasury	57.35	.....	26,077.27	13,995.97	25,000.00	65,130.59	.....
On hand	80.91	7.08	4,614.07	.....	.....	4,702.06	8,600.00
Overdrawn	.....	.....	.....	4,045.36	649.64	4,695.00	.....
Balance as above	138.26	7.08	30,691.34	9,950.61	24,350.36	65,137.65	8,600.00
Outstanding liabilities	138.26	7.08	5,000.00	3,000.00	4,500.00	12,645.34	39.00
Amounts covered by existing contracts	.....	.....	.....	.....	.....	.....	.....
Total liabilities	138.26	7.08	5,000.00	3,000.00	4,500.00	12,645.34	39.00
Balance available	.....	.....	25,691.34	6,950.61	19,850.36	52,492.31	8,561.00

*$61.55 expended by Treasury settlement No. 7,977.

First and Second districts—financial statement for the month ending May 31, 1899.

	Plum Point Reach.	Plant, first and second districts.	Hickman, Ky.	New Madrid, Mo.	Improving harbor at New Madrid, Mo.	Preservation of works.
Balance unexpended at end of last fiscal year	$270,163.82	$7,976.02	$45,910.97	$226.61	.....	$11,039.89
Appropriated and allotted during current fiscal year	60,000.00	60,000.00	.....	.....	$25,000.00	.....
Gained by transfer during current fiscal year	.....	.....	.....	.....	.....	.....
Lost by transfer during current fiscal year	42,000.00	.....	.....	.....	.....	.....
Total available	288,163.82	67,976.02	45,910.97	226.61	25,000.00	11,039.89
Expended during current fiscal year	237,322.05	53,343.16	4,113.12	208.00	6,138.97	3,289.18
Refunded during current fiscal year	.....	.....	.....	.....	.....	.....
Total disposed of	237,322.05	53,343.16	4,113.12	208.00	6,138.97	3,289.18
Balance unexpended	50,841.77	14,632.86	41,797.85	18.61	18,861.03	7,750.71
In treasury	62,500.00	20,000.00	31,843.17	.....	25,000.00	5,000.00
On hand	.....	.....	9,954.68	18.61	.....	2,750.71
Overdrawn	11,658.23	5,367.14	.....	.....	6,138.97	.....
Balance as above	50,841.77	14,632.86	41,797.85	18.61	18,861.03	7,750.71
Outstanding liabilities	5,000.00	5,000.00	.....	.....	3,000.00	.....
Amounts covered by existing contracts	8,000.00	.....	.....	.....	.....	.....
Total liabilities	13,000.00	5,000.00	.....	.....	3,000.00	.....
Balance available	37,841.77	9,632.86	41,797.85	18.61	15,861.03	7,750.71

	Surveys, gauges, and observations.	Dredging experiments.	Hopefield Bend.	Improving harbor at Memphis, Tenn.	Removal Nonconnah rock.
Balance unexpended at end of last fiscal year	$6,807.99	.....	.....	.....	.....
Appropriated and allotted during current fiscal year	.....	$35,000.00	$91,000.00	$25,000.00	$6,000.00
Gained by transfer during current fiscal year	2,000.00	15,000.00	7,431.78	.....	.....
Lost by transfer during current fiscal year	.....	.....	.....	.....	.....
Total available	8,807.99	50,000.00	98,431.78	25,000.00	6,000.00
Expended during current fiscal year	7,470.17	9,269.15	98,316.51	.....	7.20
Refunded during current fiscal year	.....	.....	.....	.....	.....
Total disposed of	7,470.17	9,269.15	98,316.51	.....	7.20
Balance unexpended	1,337.82	40,730.85	115.27	25,000.00	5,992.80
In treasury	4,500.00	45,000.00	.....	24,000.00	2,000.00
On hand	.....	.....	115.27	1,000.00	3,992.80
Overdrawn	3,162.18	4,269.15	.....	.....	.....
Balance as above	1,337.82	40,730.85	115.27	25,000.00	5,992.80
Outstanding liabilities	1,000.00	40,730.85	115.27	.....	992.80
Amounts covered by existing contracts	.....	.....	.....	.....	5,000.00
Total liabilities	1,000.00	40,730.85	115.27	.....	5,992.80
Balance available	337.82	.....	.....	25,000.00	.....

First and Second districts—Financial statement for the month ending May 31, 1893— Continued.

	Helena, Ark.	Upper Yazoo levee district.	Upper White River levee district.	Lower White River levee district.	Total.
Balance unexpended at end of last fiscal year	$1,502.80				$343,628.10
Appropriated and allotted during current fiscal year		$100,000.00	$50,000.00	$75,000.00	527,000.00
Gained by transfer during current fiscal year		4,548.65	790.39		29,770.82
Lost by transfer during current fiscal year					42,000.00
Total available	1,502.80	104,548.65	50,790.39	75,000.00	858,398.92
Expended during current fiscal year	6.70	97,453.80	22,229.13	65,444.62	604,611.76
Refunded during current fiscal year					
Total disposed of	6.70	97,453.80	22,229.13	65,444.62	604,611.76
Balance unexpended	1,496.10	7,094.85	28,561.26	9,555.38	253,787.16
In treasury	500.00	10,000.00		7,500.00	237,843.17
On hand	996.10		28,561.26	2,055.38	49,444.81
Overdrawn		2,905.15			33,500.82
Balance as above	1,496.10	7,094.85	28,561.26	9,555.38	253,787.16
Outstanding liabilities		500.00	5,000.00	1,000.00	62,338.92
Amounts covered by existing contracts			10,000.00		23,000.00
Total liabilities		500.00	15,000.00	1,000.00	85,338.92
Balance available	1,496.10	6,594.85	13,561.26	8,555.38	168,448.24

Third district—Financial statement for the month ending May 31, 1893.

	Lake Providence Reach.	Vicksburg, Miss.	Lake Bolivar Front.	Ashbrook Neck.	Plant, third district.	Surveys, gauges, and observations.
Balance unexpended at end of last fiscal year	$27,474.29	$40,089.82	$6,000.00	$107,245.84	$10,201.71	$75.54
Appropriated and allotted during current fiscal year	176,000.00				50,000.00	10,000.00
Gained by transfer during current fiscal year					25,000.00	
Lost by transfer during current fiscal year				25,000.00		
Total available	203,474.29	40,089.82	6,000.00	82,245.84	85,201.71	10,075.54
Expended during current fiscal year	178,749.26	34,050.20	3,377.20	81,231.26	79,520.00	9,777.12
Refunded during current fiscal year						
Total disposed of	178,749.26	34,050.20	3,377.20	81,231.26	79,520.00	9,777.12
Balance unexpended	24,725.03	6,039.62	2,622.80	1,014.58	5,681.71	298.42
In Treasury	15,000.00	5,000.00				1,000.00
On hand	9,725.03	1,039.62	2,622.80	1,014.58	5,681.71	
Overdrawn						701.58
Balance as above	24,725.03	6,039.62	2,622.80	1,014.58	5,681.71	298.42
Outstanding liabilities	4,725.03			1,014.58	5,681.71	298.42
Amounts covered by existing contracts	10,000.00					
Total liabilities	14,725.03			1,014.58	5,681.71	298.42
Balance available	10,000.00	6,039.62	2,622.80			

Third district—Financial statement for the month ending May 31, 1893—Continued.

	Lower Yazoo levee district.	Upper Tensas levee district.	Middle Tensas levee district.	Improving harbor at Vicksburg, Miss.	Improving harbor at Greenville, Miss.	Totals.
Balance unexpended at end of last fiscal year						$191,087.20
Appropriated and allotted during current fiscal year	$200,000.00	$310,000.00	$110,000.00	$80,000.00	$100,000.00	1,036,000.00
Gained by transfer during current fiscal year	4,091.01	3,854.12	277.47			33,222.60
Lost by transfer during current fiscal year						25,000.60
Total available	204,091.01	313,854.12	110,277.47	80,000.00	100,000.00	1,235,309.80
Expended during current fiscal year	179,172.03	286,374.80	92,936.28	24,187.74	94,758.46	1,064,134.35
Refunded during current fiscal year						
Total disposed of	179,172.03	286,374.80	92,936.28	24,187.74	94,758.46	1,064,134.35
Balance unexpended	24,918.98	27,479.32	17,341.19	55,812.26	5,241.54	171,175.45
In Treasury	24,000.00	43,000.00	7,000.00	60,000.00	5,000.00	160,000.00
On hand	918.98		10,341.19		241.54	31,585.45
Overdrawn		15,520.68		4,187.74		20,410.00
Balance as above	24,918.98	27,479.32	17,341.19	55,812.26	5,241.54	171,175.45
Outstanding liabilities	9,918.98	7,179.32	7,341.19	1,000.00		37,159.23
Amounts covered by existing contracts		5,300.00		36,512.26		51,812.26
Total liabilities	9,918.98	12,479.32	7,341.19	37,512.26		88,971.49
Balance available	15,000.00	15,000.00	10,000.00	18,300.00	5,241.54	82,203.96

Fourth district—Financial statement for the month ending May 31, 1893.

	Lower Tensas levee district.	Atchafalaya levee district.	Lafourche levee district.	Barataria levee district.	Pontchartrain levee district.	Lake Borgne levee district.	Red and Atchafalaya rivers.
Balance unexpended at end of last fiscal year							$88,697.06
Appropriated and allotted during current fiscal year	$150,000.00	$155,000.00	$90,000.00	$60,000.00	$150,000.00	$50,000.00	
Gained by transfer during current fiscal year							
Lost by transfer during current fiscal year							
Total available	150,000.00	155,000.00	90,000.00	60,000.00	150,000.00	50,000.00	88,697.06
Expended during current fiscal year	133,324.57	127,883.67	75,106.64	57,566.16	132,171.43	49,704.81	28,724.06
Refunded during current fiscal year							
Total disposed of	133,324.57	127,883.67	75,106.64	57,566.16	132,171.43	49,704.81	28,724.06
Balance unexpended	16,675.43	27,116.33	14,893.36	2,433.84	17,828.57	295.19	59,973.00
In Treasury	15,000.00	25,000.00	15,000.00	5,000.00	20,000.00	5,000.00	58,000.00
On hand	1,675.43	2,116.33					1,973.00
Overdrawn			106.64	2,566.16	2,171.43	4,704.81	
Balance as above	16,675.43	27,116.33	14,893.36	2,433.84	17,828.57	295.19	59,973.00
Outstanding liabilities							
Amounts covered by existing contracts	15,319.99		10,725.59		12,991.49		59,973.00
Total liabilities	15,319.99		10,725.59		12,991.49		59,973.00
Balance available	1,355.44	27,116.33	4,167.77	2,433.84	4,837.08	295.19	

Fourth district—Financial statement for the month ending May 31, 1883.—Continued.

	Surveys, gauges, and observations.	Improving Mississippi River.	Improving harbor at New Orleans, La.	Improving Atchafalaya and Red Rivers, Louisiana.	Improvements at Natchez and Vidalia, Miss. and La.	Total.
Balance unexpended at end of last fiscal year	$626.42	$89,323.48				$89,323.48
Appropriated and allotted during current fiscal year	12,000.00	667,000.00	$80,000.00	$80,000.00	$80,000.00	907,000.00
Gained by transfer during current fiscal year						
Lost by transfer during current fiscal year						
Total available	12,626.42	756,323.48	80,000.00	80,000.00	80,000.00	996,323.48
Expended during current fiscal year	6,073.33	610,554.67	80,000.00		1,420.47	691,975.14
Refunded during current fiscal year						
Total disposed of	6,073.33	610,554.67	80,000.00		1,420.47	691,975.14
Balance unexpended	6,553.09	145,768.81		80,000.00	78,579.53	304,348.34
In Treasury	6,000.00	149,000.00	5,000.00	80,000.00	75,000.00	309,000.00
On hand	553.09	6,317.85			3,579.53	9,897.38
Overdrawn		9,549.04	5,000.00			14,549.04
Balance as above	6,553.09	145,768.81		80,000.00	78,579.53	304,348.34
Outstanding liabilities						
Amounts covered by existing contracts		99,010.07		2,727.00		101,737.07
Total liabilities		99,010.07		2,727.00		101,737.07
Balance available	6,553.09	46,758.74		77,273.00	78,579.53	202,611.27

Detailed statement, March 3, 1881, to May 31, 1883. Expended allotments.

Districts.	Balances.	Appropriations and allotments.	Expended.	Total.
Des Moines Rapids to Illinois River	$12,000.00	$195,000.00		207,000.00
Illinois River to Ohio River	9,626.42	470,000.00		479,626.42
Total	21,626.42	665,000.00		686,626.42
Survey, St. Francis Front		1,500.00		1,500.00
New Madrid Reach		200,000.00		200,000.00
Columbus, Ky		45,000.00		45,000.00
Gauges		1,500.00		1,500.00
Observations and discharges		500.00		500.00
Surveys examinations, and inspections		500.00		500.00
Levees—Plum Point		175,000.00		175,000.00
Survey, St. Francis Front		1,000.00		1,000.00
Survey Helena Reach		500.00		500.00
Levees:				
Long Lake		1,000.00		1,000.00
Yazoo-Mississippi Delta		1,000.00		1,000.00
Protection of levees				
Memphis Reach		100,000.00		100,000.00
Memphis Harbor and Reach		500.00		500.00
Gauges				
Observations and discharges		500.00		500.00
Surveys examinations, and inspections		500.00		500.00
Care of plant, first and second districts		500.00		500.00
Surveys, first and second districts		2,000.00		2,000.00
Levees:				
Yazoo Front		1,000.00		1,000.00
White River Basin		1,000.00		1,000.00
Upper Mississippi Levee District		1,000.00		1,000.00
Memphis		1,000.00		1,000.00
Total, first and second districts		2,262,500.00	1,420.47	2,261,079.53
Survey, Vicksburg Harbor		2,500.00		2,500.00
Survey, unleveed front		1,000.00		1,000.00
Survey, Choctaw Reach		2,000.00		2,000.00

Detailed statement, March 3, 1881, to May 31, 1893. (*Expended allotments.*)—Cont'd.

Districts.	Balances.	Appropriations and allotments.	Applied by general service.	Total.
Levees:				
Opossum Fork		$120,000.00		$120,000.00
Yazoo Front		364,878.95		364,878.95
Yazoo Front—Ben Lomond		11,386.22		11,386.22
Yazoo Front—Hughes Break		6,849.69		6,849.69
Tensas Front		566,723.00		566,723.00
Protection of levees		216,431.83		216,431.83
Protection of existing works		25,000.00		25,000.00
Repairs to floating plant		30,000.00		30,000.00
Vicksburg Harbor—Delta Point	$25,770.13	107,579.88		133,350.01
Care of plant and surveys		24,360.00		24,360.00
Lake Bolivar front		116,329.85	$8,028.19	124,358.04
Gauges		1,461.10		1,461.10
Observations and discharges		3,000.00		3,000.00
Surveys, examinations, and inspections		10,149.46		10,149.46
Greenville, Miss		348,499.02	58,144.00	406,643.02
Levees:				
Lower Mississippi levee district		289,944.54		289,944.54
Tensas Basin, Louisiana		160,072.27		160,072.27
Tensas Basin, Arkansas		399,591.09		399,591.09
Floating dock		20,000.00		20,000.00
Total, third district	25,717.13	2,528,436.76	66,172.19	2,920,379.08
Survey:				
Cubitt's Gap		137.14		137.14
Unleveed fronts		1,000.00		1,000.00
Observations at Carrollton		3,000.00		3,000.00
Bonnet Carre Crevasse		15,000.00		15,000.00
Natchez and Vidalia harbors	8,252.04			8,252.04
Mouth of Red River	90,812.40	38,405.00		129,217.40
Natchez, Miss. (survey)		1,500.00		1,500.00
Gauges		1,878.11		1,878.11
Observations and discharges		9,000.00		9,000.00
Levees—Atchafalaya front		176,800.00		176,800.00
Protection of levee—Tensas front		23,000.00		23,000.00
Protection of levees		104,000.00		104,000.00
Surveys, examinations, and inspections		4,000.00		4,000.00
New Orleans Harbor	147,670.37	389,183.86	1,527.61	538,381.86
Levees:				
Tensas Basin		1,163,477.00		1,163,477.00
Right bank below Red River		191,892.00		191,892.00
Left bank below Red River		134,116.00		134,116.00
Total, fourth district	246,734.83	2,256,389.11	1,527.61	2,504,651.55
Reduction of observations		2,500.00		2,500.00
Total, secretary's office		2,500.00		2,500.00
Grand total	295,137.49	7,914,838.34	279,435.32	8,489,411.15

Detailed statement, March 3, 1881, to May 31, 1893. (Current allotments.)

Districts.	Appropriations and allotments.	Applied by general service.	Total available.	Expended.	Total balances.
Protection near Cairo	$50,000.00		$50,000.00	$41,400.00	$8,600.00
Total above Cairo	50,000.00		50,000.00	41,400.00	8,600.00
First and second districts.					
Plum Point Reach	3,314,821.18	$364,515.50	3,679,336.68	3,628,494.91	50,841.77
Plant, first and second district	190,507.35	5,017.40	195,524.75	180,891.89	14,632.86
Hickman, Ky	85,343.17	3,288.83	89,132.00	47,334.15	41,797.85
New Madrid, Mo	1,000.00		1,000.00	981.39	18.61
Improving harbor at New Madrid, Mo	25,000.00		25,000.00	6,138.97	18,861.03
Preservation of works, first and second districts	20,680.42	3,187.47	23,867.89	16,117.18	7,750.71
Surveys, gauges, and observations	20,479.03		20,479.03	19,141.21	1,337.82
Dredging experiments	50,000.00		50,000.00	9,269.15	40,730.85
Hopefield Bend	98,431.78		98,431.78	98,316.51	115.27
Improving harbor, Memphis, Tenn.	25,000.00		25,000.00		25,000.00
Removal of Nonconnah Rock	6,000.00		6,000.00	7.20	5,992.80
Helena, Ark	66,106.83	10,393.17	76,500.00	75,003.90	1,496.10
Upper Yazoo levee district	104,548.65		104,548.65	97,453.80	7,094.85
Upper White River levee district	50,790.39		50,790.39	22,229.13	28,561.26
Lower White River levee district	75,000.00		75,000.00	65,444.62	9,555.38
Total, first and second districts	4,134,208.80	386,402.37	4,520,611.17	4,266,824.01	253,787.16
Third district.					
Lake Providence Reach	2,975,876.34	255,046.96	3,230,923.30	3,206,198.27	24,725.03
Vicksburg, Miss	366,968.70	2,662.27	369,630.97	363,591.35	6,039.62
Lake Bolivar front	6,000.00		6,000.00	3,377.20	2,622.80
Ashbrook Neck	317,000.00	49,003.87	366,003.87	364,989.29	1,014.58
Plant, third district	231,331.17	17,095.54	248,426.71	242,745.00	5,681.71
Surveys, gauges, and observations	22,138.90		22,138.90	21,840.48	298.42
Lower Yazoo levee district	204,091.01		204,091.01	179,172.03	24,918.98
Upper Tensas levee district	313,854.12		313,854.12	286,374.80	27,479.32
Middle Tensas levee district	110,277.47		110,277.47	92,936.28	17,341.19
Improving harbor, Vicksburg, Miss.	80,000.00		80,000.00	24,187.74	55,812.26
Improving harbor, Greenville, Miss.	100,000.00		100,000.00	94,758.46	5,241.54
Total, third district	4,727,537.71	323,808.64	5,051,346.35	4,880,170.90	171,175.45
Fourth district.					
Lower Tensas levee district	150,000.00		150,000.00	133,324.57	16,675.43
Atchafalaya levee district	155,000.00		155,000.00	127,883.67	27,116.33
Lafourche levee district	90,000.00		90,000.00	75,106.64	14,893.36
Barataria levee district	60,000.00		60,000.00	57,566.16	2,433.84
Pontchartrain levee district	150,000.00		150,000.00	132,171.43	17,828.57
Lake Borgne levee district	50,000.00		50,000.00	49,704.81	295.19
Red and Atchafalaya rivers	657,500.00		657,500.00	597,527.00	59,973.00
Surveys, gauges, and observations	25,121.89		25,121.89	18,568.80	6,553.09
Improving harbor, New Orleans, La.	80,000.00		80,000.00	80,000.00	
Improving Atchafalaya and Red rivers, Louisiana	80,000.00		80,000.00		80,000.00
Improving harbor, Natchez and Vidalia	80,000.00		80,000.00	1,420.47	78,579.53
Total, fourth district	1,577,621.89		1,577,621.89	1,273,273.55	304,348.34
Mississippi River Commission	75,000.00		75,000.00	*65,049.39	9,950.61
Surveys, gauges, and observations	198,345.33		198,345.33	†167,653.99	30,691.34
Rebuilding steamer Mississippi	25,000.00		25,000.00	649.64	24,350.36
Total, secretary's office	298,345.33		298,345.33	233,353.02	64,992.31
Grand total	10,787,713.73	710,211.01	11,497,924.74	10,695,021.48	802,903.26

*Includes $4.03 disbursed by Treasury settlement No. 7130.
†Includes $61.55 disbursed by Treasury settlement No. 7977.

Consolidated statement, March 3, 1881, to May 31, 1893.

Act of—		
March 3, 1881		$1,000,000.00
August 2, 1882		4,123,000.00
January 19, 1884		1,000,000.00
July 5, 1884, less $5,000 transferred to snag-boat service		2,065,000.00
August 5, 1886, less $5,942.60 for expenses, office Chief of Engineers		1,994,057.40
August 11, 1888, less $4,859 for expenses, office Chief of Engineers.		2,840,141.00
September 19, 1890		3,200,000.00
March 3, 1891		1,000,000.00
July 13, 1892		2,470,000.00
Total specific appropriations		19,692,198.40
Balances from former appropriations applied to works below Cairo under act of August 2, 1882, less $123.42 reverted to treasury	$272,501.96	
Same for works above Cairo, under act of July 5, 1884.	22,637.53	
Total balances		295,137.49
Total available		19,987,335.89
Expended—		
Plum Point Reach		3,628,494.91
Memphis Harbor and Reach		1,150,535.77
Lake Providence		3,206,198.27
Red and Atchafalaya		726,744.40
Levees		6,090,947.64
Other works		4,381,511.64
Total		19,184,432.63
Balance May 31, 1893		802,903.26

Statement of charts issued, June 1, 1892, to May 31, 1893.

Description.	Free.	Sold.	Total.
Alluvial Valley	80	306	386
Scale 1:20,000	435	249	684
Scale 1 inch: 1 mile	2,160	1,121	3,281
Proceeds of sale deposited with assistant treasurer of the United States at St. Louis			$99.10

List of civilian engineers employed on work of river and harbor improvements in charge of Capt. Carl F. Palfrey, Corps of Engineers, July 1, 1892, to May 31, 1893.

Name and residence.	Time employed.		Compensation.	Where employed.	Work on which employed.
	M.	D.	Per Mo.		
J. A. Ockerson, St. Louis, Mo	11	00	$250.00	St. Louis, Mo	In charge surveys, S. G. O.
Kivas Tully, St. Louis, Mo	11	00	175.00	do	In charge computation S. G. O.
C. W. Clark, St. Louis, Mo	11	00	175.00	do	Plotting maps, S. G. O.
Chas. W. Stewart, Champaign Ill	2	9	150.00	In the field and in office, St. Louis, Mo	Surveys and reduction of field work.
James A. Paige, St. Louis Mo	4	13	175.00		
A. T. Morrow, Mendota, Ill	2	..	110.00		
Do	9	..	175.00		
George H. French, Milton, Ill	2	..	120.00		
O. W. Connet, Houghton, Mich	..	3	120.00		

Approximate value of plant belonging to the United States, in charge of Capt. Carl F. Palfrey, Corps of Engineers, used in works under the Mississippi River Commission.

Allotment.	Class of property.	No.	Approximate value May 31, 1893.
Mississippi River Commission	Steamboat Mississippi (hull only)	1	$20,000
	Row boats	2	40
	Books, furniture, etc.	.....	250
Surveys, gauges, and observations	Steamboat Patrol, with outfit	1	11,000
	Quarter boat, with outfit	1	1,500
	Quarter boat (condemned)	1	.....
	Row boats	15	200
	Surveying instruments	.....	10,000
	Current meters	7	1,100
	Drawing instruments	.....	700
	General tools	.....	500
	Printing plant	.....	700
	Office furniture	.....	750

APPENDIX 3 A.

REPORT OF ASSISTANT ENGINEER CHARLES W. STEWART ON SECONDARY TRIANGULATION FROM PORT LOUISA, IOWA, TO NEAR MOUTH OF GALENA RIVER, ILLINOIS (NINE MILES BELOW DUBUQUE).

ST. LOUIS, MO., *September 2, 1892.*

CAPTAIN: I have the honor to submit the following report on fieldwork of secondary triangulation from March 28, to August 30, 1892, between Port Louisa, Iowa, and near mouth of Galena River, Illinois, 9 miles below Dubuque.

A reconnaissance was made between these limits from March 28 to April 25 by myself and Assistant George H. French, and the party took the field at New Boston, Ill., on April 26, the steamer *Patrol* furnishing quarters and transportation.

The instruments furnished were T. and S., Nos. 1 and 2; Gambey, No. 2; Wurdeman, Nos. 95 and 154; a B. and B. transit and level, and Missouri River Commission tape II, and Missouri River Commission tension apparatus.

The program of observations and general method was the same as during the preceding season.

The arrangements of men and officers was as follows: In charge of party, Assistant Charles W. Stewart; observers, Charles W. Stewart, A. T. Morrow; stone lines, A. T. Morrow, O. N. Axtell; stations and clearing, George H. French, T. C. Hockridge; secondary recorders, C. L. Ockerson, M. I. Powers. A steamboat crew of 5, 1 rodman, galley force of 4, and 13 axmen completed the party.

The length and azimuth of a base line at Rapids City, Ill., was determined and connected with, and the work was closed on the U. S. C. and G. S. line △ Horseshoe Mound, Illinois, △ Sinsinawa Mound, Wisconsin, on August 25. The *Patrol* and party started for Quincy, Ill., on following day, arriving August 29, and was turned over to Assistant A. T. Morrow for topographical work, and the triangulation records forwarded to this office.

A summary of the work done is as follows:

Secondary base-azimuth	1
Secondary stations established	72
Cupolas located	3
Built stations (average height, 25 feet)	46
Ground stations	23
Secondary stations occupied	76
Secondary triangles closed	72
Stone lines located (136–176)	41
Stone line B. Ms located	120
Tertiary stone-line triangles	133
Tertiary stone-line bases measured	12

The astronomical post and meridian mark at Rock Island Arsenal were connected with.

The average error of closure of secondary triangles is 01″.88, indicating a high grade of work.

The total number of days in the field, April 26 to August 26, is 122. There were 17 Sundays and about 35 stormy days on which little or no work could be done, leav-

ing 70 working days in which the triangulation and stone lines were c
miles (channel distance).

The phaseless target designed by Assistant Engineer J. A. Ockerson was
all secondary stations. It is an important factor in the good results obt
is the handiwork of Mr. Thomas Hebron, steam engineer of the *Patrol*.

Despite the many discouragements of general bad weather, fair progres
made.

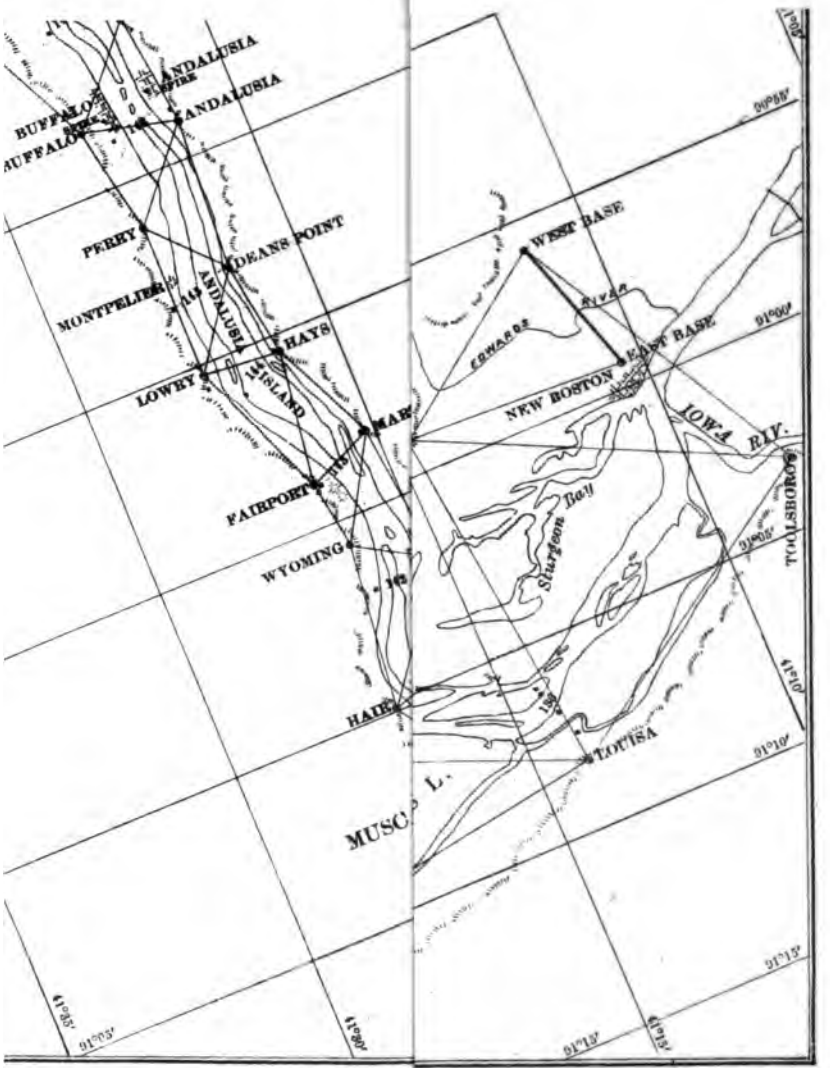
It is respectfully suggested that, if practicable, the services of the
retained.

My thanks are due the party generally for zeal, efficiency, and cheerfu
especially to Assistant A. T. Morrow.

Respectfully submitted.

CHAS. W. STEWA
U. S. Assistant

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.


ANDALUSIA
ANDALUSIA
PERRY
DEANS POINT
MONTPELIER
ANDALUSIA
HAYS
LOWRY
ISLAND
FAIRPORT
WYOMING
HAIG
WEST BASE
EAST BASE
NEW BOSTON
IOWA RIV.
Sturgeon Bay
TOOLSBORO
TOOTSA
MUSC
91°58'
91°00'
91°08'
91°10'
91°15'
41°10'

Geographical positions north of Keokuk, Iowa.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.			Seconds, in meters.	Longitude.			Seconds, in meters.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″		°	′	″		°	′	″	°	′	″		*Meters.*
West Base	41	10	22.84	704.6	90	59	32.62	760.5	184	30	18.8	4	30	36.8	Sturgeon	8,057.4
									253	18	49.1	73	21	18.1	East Base	5,506.4
East Base	41	11	14.03	432.8	90	55	46.29	1,078.9	144	18	26.5	324	16	15.3	Sturgeon	7,947.7
									61	01	43.3	240	56	42.4	Toolsboro	11,942.0
Sturgeon	41	14	43.22	1,333.3	90	59	05.44	126.7	25	21	36.5	205	18	52.7	do	13,548.5
									84	03	51.4	263	57	48.4	Louisa	12,894.2
									140	14	21.4	320	10	29.2	Fruitland	12,790.6
Louisa	41	13	59.63	1,839.6	91	08	16.13	375.6	202	29	02.4	22	31	13.6	do	12,093.2
									171	20	55.7	351	19	35.8	Hardtimes	18,685.2
									327	07	50.1	147	11	08.9	Toolsboro	12,974.1
Toolsboro	41	08	06.28	193.7	91	03	14.23	331.9	230	37	15.1				New Boston Spire	6,289.5
Fruitland	41	20	01.80	55.5	91	04	57.25	1,331.3	134	30	16.7	314	26	45.3	Hardtimes	10,418.9
									194	39	46.0	14	40	55.2	Muscatine	9,606.7
									247	08	24.0	67	11	35.4	Carruthers	7,306.1
Hardtimes	41	23	58.42	1,802.3	91	10	17.13	398.1	258	31	51.0	78	36	31.8	Muscatine	10,061.3
Muscatine	41	25	03.05	94.1	91	03	12.54	291.2	326	20	55.1	146	22	57.4	Carruthers	7,756.8
									276	05	52.5	96	08	33.2	Campbell	5,673.7
									237	24	12.3	57	26	22.2	Hair	5,413.1
Carruthers	41	21	33.71	1,040.0	91	00	07.62	177.1	192	57	22.9	12	58	01.2	Campbell	6,606.4
Campbell	41	24	43.44	1,340.1	90	59	09.64	223.9	162	57	56.2	342	57	25.5	Hair	3,681.2
									265	36	59.0	85	38	33.8	Hershey	3,336.3
Hair	41	26	37.53	1,157.8	90	59	56.09	1,302.0	306	32	06.3	126	34	11.8	do	5,482.8
									276	30	06.2	96	32	56.6	Wyoming	6,016.0
Hershey	41	24	51.68	1,594.4	90	56	46.40	1,077.5	211	21	34.7	31	22	19.6	do	3,023.5
									264	28	11.5	84	30	37.2	Martin	5,137.2
Wyoming	41	26	15.36	473.9	90	55	38.63	896.9	300	31	56.7	120	33	37.6	do	4,109.1
									261	55	52.5	81	57	00.3	Fairport	2,402.0
Martin	41	25	07.67	236.6	90	53	06.22	144.5	154	26	17.3	334	25	44.3	do	2,688.4
									244	11	28.6	64	13	14.8	Hays	4,143.1
Fairport	41	26	26.28	810.7	90	53	56.19	1,304.6	277	14	03.5	97	16	22.9	do	4,929.1
									246	42	46.7	66	45	11.6	Lowry	5,531.5
Hays	41	26	06.11	188.5	90	50	25.58	594.0	183	55	45.8	3	55	51.3	do	2,814.0
									261	08	24.5	81	10	01.3	Deans Point	3,435.3
Lowry	41	27	37.10	1,144.6	90	50	17.27	400.8	305	26	17.3	125	27	48.6	do	3,929.4
									270	35	05.6	90	37	47.6	Perry	5,678.6
Deans Point	41	26	23.23	716.6	90	47	59.37	1,378.5	228	09	06.2	48	10	16.9	do	3,326.5
									274	05	07.0	94	07	44.1	Andalusia	5,524.6
Perry	41	27	35.15	1,084.4	90	46	12.60	292.4	310	45	58.4	130	47	24.8	do	4,003.1
									257	54	33.1	77	56	22.6	Buffalo	3,923.3

Geographical positions north of Keokuk, Iowa—Continued.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.	Seconds, in meters.	Longitude.	Seconds, in meters.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″		° ′ ″		° ′ ″	° ′ ″		Meters.
Andalusia	41 29 [illegible] 46	[illegible]	90 44 02.62	46.9	193 12 06.9	13 12 29.8	Buffalo	5,528.6
					262 23 12.1	82 25 09.0	Bean	4,134.2
					200 59 48.1	21 00 15.3	Buffalo Spire	2,663.1
					243 25 41.9	63 26 21.1	Andalusia Spire	1,536.8
Buffalo	41 28 [illegible] 50	51.5	90 43 27.29	633.3	311 15 45.7	131 17 19.5	Bean	4,378.9
					244 51 38.2	64 54 18.1	Anderson	6,187.1
					351 06 50.5	171 06 54.8	Buffalo Spire	960.6
					348 16 29.8	168 16 46.1	Andalusia Spire	2,805.6
Buffalo Spire	41 [illegible] [illegible] 50	[illegible]	90 43 29.90	484.9				
Andalusia Spire	41 [illegible] [illegible] 72	1,[illegible]	90 43 02.73	63.4				
Bean	41 [illegible] [illegible] 12	867.5	90 41 05.50	127.7	202 44 34.9	22 45 40.9	Anderson	5,940.3
					282 51 11.4	102 52 59.7	Kane	3,896.0
					121 41 37.0	301 40 07.3	Buffalo Spire	3,033.1
					211 44 12.4	31 45 15.1	Kimball	4,181.6
Anderson	41 29 [illegible] 88	829.3	90 39 25.84	599.5	346 54 26.7	166 55 09.0	Kane	6,552.8
					264 30 12.7	84 32 54.1	Beatty	5,676.2
					223 19 13.8	43 20 57.8	Davenport	5,301.5
Kane	41 [illegible] [illegible] 90	1,[illegible]	90 38 21.91	508.8	211 02 12.8	31 04 11.8	Beatty	8,082.4
					160 09 15.7	340 08 30.2	Kimball	4,702.9
Kimball	41 [illegible] [illegible]	727.5	90 39 30.72	712.9	56 56 25.7	236 53 26.1	Andalusia	7,515.9
Beatty	41 29 41.43	1,[illegible]	90 35 22.25	516.1	148 48 31.4	328 47 34.0	Davenport	3,877.6
					204 01 04.1	24 04 49.1	School	3,854.1
					250 46 29.1	70 47 34.0	Rock Island	2,742.1
					322 07 02.1		Arsenal Tower	
					224 22 24.1	44 23 01.2	R. I. Spire	1,858.9
[illegible]	[illegible]	[illegible]	90 36 48.87	1,132.9	266 45 18.8	86 47 01.2	School	3,585.7
School	41 [illegible] [illegible]	1,[illegible]	90 34 14.46	355.2	338 45 39.4	158 46 08.4	Rock Island	2,806.3
					261 09 08.8	81 10 27.3	McClellan	2,776.8
					322 17 31.2	142 17 54.4	R. I. Astron. Post	1,328.9
					335 22 30.4	155 22 45.9	Arsenal Tower	1,290.7
					258 27 30.0	78 27 53.3	Renwicks	829.7
					7 05 09.4	187 05 01.6	R. I. Spire	2,207.1
					294 03 09.6		Arsenal Stack	2,586.7
Rock Island	41 30 [illegible] 80	422.4	90 33 30.62	710.2	209 34 51.8	29 35 41.1	McClellan	3,499.1
					268 12 35.8	88 13 41.2	Moline	2,289.7
					117 43 27.5		Davenport	
					108 17 37.2		R. I. Spire	1,257.6
					158 47 38.6	338 47 09.6	Dav. School Flg. Stf	2,807.1
					215 17 10.4	35 17 43.6	Arsenal Stack	2,015.1
					142 03 37.9	322 02 21.3	Davenport C. H	4,356.7
					161 40 49.1		Arsenal Tower	
					175 48 58.8	355 48 53.0	Renwicks	2,780.7

R. I. Astronomical Post	41	31	04.42	136.4	90	33	39.41	913.8	180 00 44.1			.....	do	.....
									64 22 38.9			244 22 31.2	Arsenal Tower	300.9
Renwicks	41	31	43.87	1,353.4	90	33	39.40	913.4	.....			.....	.....	.....
Arsenal Tower	41	31	00.20	6.2	90	33	51.10	1,184.9	.....			.....	.....	.....
R. I. Spire	41	30	27.50	848.4	90	34	26.20	607.8	.....			.....	.....	.....
Arsenal Stack	41	31	06.05	214.4	90	32	40.46	938.2	.....			.....	.....	.....
Davenport C. H.	41	32	05.05	155.8	90	35	26.16	606.4	.....			.....	.....	.....
McClellan	41	31	52.32	1,614.2	90	32	16.11	373.6	349 19 03			169 19 19	Moline	3,024.1
									272 16 43			92 18 11	Gilberttown	3,105.7
									53 52 34			233 51 31	Arsenal Tower	2,727.1
									82 19 11			262 18 16	Renwicks	1,948.5
									81 11 03			261 09 45	Davenport School flag-staff	2,775.6
									95 06 35			275 04 29	Davenport C. H.	4,423.5
									21 58 29			201 58 13	Arsenal Stack	1,509.3
									351 00 09			171 09 21	Moline School	2,910.6
Moline School	41	30	19.10	589.2	90	31	56.80	1,317.4	.....			.....	.....	.....
Moline	41	30	16.00	493.6	90	31	51.94	1,204.7	221 45 34			41 46 47	Gilberttown	3,818.1
									259 37 07			79 38 50	Race Track	3,654.9
Gilberttown	41	31	48.30	1,490.1	90	30	02.26	52.4	334 21 09			154 21 39	do	2,429.2
									240 59 51			61 01 30	Crow	3,960.0
									43 59 47			223 58 32	Moline School	3,824.6
Race Track	41	30	37.31	1,151.0	90	29	16.92	392.4	210 24 57			30 26 06	Crow	4,765.3
									244 56 50			64 59 29	Watertown	6,141.4
Crow	41	32	50.50	1,558.0	90	27	32.83	760.9	295 36 24			115 37 55	do	3,493.7
									261 00 32			81 02 31	Hampton	4,211.9
									224 15 23			44 16 31	Valley City	3,410.2
Watertown	41	32	01.54	47.5	90	25	16.93	392.5	168 59 33			348 59 10	do	4,026.7
									204 59 40			25 00 09	Hampton	2,391.7
Hampton	41	33	11.80	864.0	90	24	33.38	772.5	135 05 52			315 05 01	Valley City	2,520.5
									183 42 39			3 42 44	Fulton	2,621.0
									230 41 44			50 42 45	Crab Island	2,794.4
									118 59 24			298 59 15	Hampton School	349.5
									146 38 36			326 38 29	Hampton Spire	448.4
Valley City	41	34	09.66	298.0	90	25	50.12	1,161.3	246 54 47			66 55 43	Fulton	2,118.3
Hampton School	41	33	17.29	533.4	90	24	46.52	1,078.2	.....			.....	.....	.....
Hampton Spire	41	33	23.94	738.6	90	24	43.97	1,019.0	.....			.....	.....	.....
Fulton	41	34	36.57	1,128.2	90	24	26.00	602.4	292 59 23			113 00 20	Crab Island	2,164.5
									256 26 49			75 28 15	Sycamore	3,106.8
									10 59 55			190 59 41	Hampton School	2,491.7
									10 31 23			190 31 11	Hampton Spire	2,279.1
Crab Island	41	34	09.16	282.6	90	23	00.00	0.0	211 58 34			31 59 03	Sycamore	1,916.6
									244 17 36			64 18 18	Lower Base	1,601.1
Sycamore	41	35	01.86	57.4	90	22	16.19	375.0	335 20 16			155 20 28	do	1,024.7
									280 30 45			100 31 40	Upper Base	1,959.2
Lower Base	41	34	31.67	977.0	90	21	57.73	1,337.3	249 03 05			69 03 47	do	1,604.8
Upper Base	41	34	50.26	1,550.6	90	20	53.04	1,228.6	.....			.....	.....	.....

Geographical positions of tertiary points north of Keokuk, Iowa.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.			Seconds, in meters.	Longitude.			Seconds, in meters.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″		°	′	″		°	′	″	°	′	″		*Meters.*
⊡ 12/8	41	14	21.10	650.9	91	06	07.01	163.3	67	30	39	247	30	33	⊡ 12/6	244.0
⊡ 12/6	41	14	18.08	557.8	91	06	16.69	388.7	67	26	02	247	25	39	⊡ 12/5	874.2
⊡ 12/5	41	14	07.20	222.1	91	06	51.35	1,195.8	71	57	37	251	57	10	⊡ 12/4	985.8
⊡ 12/4	41	13	57.30	1,767.7	91	07	31.60	736.0	93	58	58	273	58	28	Ⓐ Louisa	1,039.7
⊡ 12/7	41	17	05.41	166.9	91	04	58.46	1,380.5	111	12	16	291	12	05	⊡ 12/2	414.0
⊡ 12/7	41	17	10.26	316.5	91	05	15.05	350.2	111	17	51	291	17	32	⊡ 12/3	688.4
⊡ 12/7	41	17	18.37	566.7	91	05	42.62	991.8								
⊡ 12/8	41	18	57.68	1,779.5	91	03	10.47	243.5	113	20	47	293	20	15	⊡ 12/8	1,205.5
⊡ 12/9	41	19	13.16	406.0	91	03	58.06	1,350.5	113	34	32	293	34	07	⊡ 12/9	975.4
									137	28	24	317	27	45	Ⓐ Fruitland	2,036.3
⊡ 12/3	41	19	25.80	795.9	91	04	36.49	848.8	156	30	39	336	30	25	do	1,210.8
									101	54	49				P. B. M. 26	29.1
P. B. M. No. 26	41	19	26.00	802.1	91	04	37.72	877.4								
⊡ 12/0	41	21	44.89	1,384.9	91	03	13.54	314.7	99	38	34	279	38	15	⊡ 12/2	693.2
⊡ 12/9	41	21	48.65	1,500.9	91	03	42.94	998.0	99	38	47	279	38	22	⊡ 12/3	889.3
⊡ 12/2	41	21	53.48	1,649.9	91	04	20.67	480.4	100	27	59	280	27	27	⊡ 12/4	1,154.6
⊡ 12/1	41	22	00.27	8.3	91	05	09.52	221.3	355	32	12	175	32	20	Ⓐ Fruitland	
⊡ 12/0	41	24	07.61	234.8	91	02	27.98	650.0	127	28	23	307	28	12	⊡ 12/0	486.0
⊡ 12/0	41	24	17.19	530.3	91	02	44.59	1,035.8	127	35	48	307	35	29	⊡ 12/0	828.0
									155	21	08	335	20	49	Ⓐ Muscatine	1,556.3
⊡ 12/5	41	24	33.57	1,035.7	91	03	12.84	298.2	138	33	10	318	32	51	⊡ 12/5	1,008.6
									180	26	07	0	26	07	Ⓐ Muscatine	909.4
⊡ 12/6	41	24	58.07	1,791.5	91	03	41.58	965.6	10	53	47	190	52	57	Ⓐ Fruitland	9,307.5
									257	11	12	77	11	31	Ⓐ Muscatine	691.7
⊡ 12/1	41	25	31.24	963.8	91	00	13.13	304.9	156	51	50	336	51	34	⊡ 12/1	1,420.6
									156	52	57	336	52	36	⊡ 12/1	
									190	57	02	10	57	13	Ⓐ Hair	2,082.9
⊡ 12/3	41	26	13.58	419.0	91	00	37.18	863.2	156	56	05	336	55	59	⊡ 12/1	501.6
									232	15	09	52	15	35	Ⓐ Hair	1,206.5
⊡ 12/1	41	26	28.54	880.5	91	00	45.64	1,059.6								
⊡ 12/2	41	24	58.20	1,795.5	90	57	06.07	141.0	186	13	38	6	13	44	⊡ 12/2	2,129.3
⊡ 12/2	41	26	06.81	210.1	90	56	56.13	1,303.2	102	47	38	282	45	39	Ⓐ Hair	4,284.1
⊡ 12/3	41	25	13.09	403.8	90	53	06.46	150.0	358	09	17	178	09	18	Ⓐ Martin	167.4
									148	26	15	328	25	39	⊡ 12/3	2,396.5
									152	55	04	332	54	33	Ⓐ Fairport	
⊡ 12/3	41	26	19.28	594.8	90	54	00.50	11.6	274	38	14	94	40	36	Ⓐ Hayes	5006.3
									330	17	27	150	18	03	Ⓐ Martin	2543.4
									204	49	55	24	49	58	Ⓐ Fairport	238.0
⊡ 12/4	41	26	12.23	377.3	90	50	23.36	542.4	171	41	28	351	41	18	⊡ 12/5	2653.8
									95	01	52	274	59	32	Ⓐ Fairport	4960.0
⊡ 12/4	41	26	59.57	1837.8	90	51	09.49	220.3	210	31	04	30	31	23	⊡ 12/4	1352.9

⊙ 1$\frac{1}{2}$[A]	41	27	37.85	1152.3	90	50	39.88	925.5	353	16	16	178	16	26	◬ Hayes	2834.5
									64	19	17	244	17	07	◬ Fairport	5056.7
⊙ 1$\frac{1}{2}$[4]	41	26	26.02	802.7	90	47	57.65	1338.5	124	05	50	304	04	18	◬ Lowry	3913.1
									228	48	50	48	49	59.6	◬ Perry	3239.4
									163	50	41	343	50	22	⊡ 1$\frac{1}{2}$[3]	2374.4
⊙ 1$\frac{1}{2}$[8]	41	27	39.95	1232.5	90	48	26.11	605.9	345	18	08	165	18	25	◬ Deans Point	2446.7
									43	46	46	223	45	27	◬ Hayes	4008.9
⊙ 1$\frac{1}{2}$[4]	41	26	15.11	466.2	90	43	42.41	984.7	172	11	12	352	11	03	⊡ 1$\frac{1}{2}$[3]	2286.5
									92	25	45	272	22	55	◬ Deans Point	5970.7
									72	17	54	252	17	41	◬ Andalusia	477.9
⊙ 1$\frac{1}{2}$[2]	41	27	28.53	880.2	90	43	55.80	1295.2	3	25	39	183	25	35	◬ Andalusia	2414.7
									70	24	34	250	21	53	◬ Deans Point	6002.1
⊙ 1$\frac{1}{2}$[1]	41	26	40.36	1245.1	90	40	22.76	528.3	120	23	55	300	21	53	◬ Buffalo	4964.8
									200	48	16	20	48	50	△ Kimball	3400.1
															⊡ 1$\frac{1}{2}$[1]	
⊙ 1$\frac{1}{2}$[7]	41	27	50.62	1561.7	90	40	44.75	1038.4	10	43	04	190	42	50	◬ Bean	2500.2
									55	59	27	235	57	16	◬ Andalusia	5524.9
⊙ 1$\frac{1}{2}$[6]	41	28	33.28	1026.7	90	37	36.45	845.6	135	56	30	315	56	11	⊡ 1$\frac{1}{2}$[2]	950.9
									83	26	13	263	24	58	△ Kimball	2668.9
⊙ 1$\frac{1}{2}$[5]	41	28	55.43	1710.0	90	38	04.96	115.1	144	54	49	294	54	09	⊡ 1$\frac{1}{2}$[2]	1560.5
									63	35	02	243	34	06	△ Kimball	2222.1
⊙ 1$\frac{1}{2}$[4]	41	29	16.86	520.1	90	39	06.32	146.6	18	56	39	198	56	23	△ Kimball	1744.3
⊙ 1$\frac{1}{2}$[2]	41	30	01.20	37.0	90	35	09.06	210.1	30	37	10	210	37	01	◬ Beatty	601.0
									260	24	36	80	25	41	◬ Rock Island	2315.4
															⊡ 1$\frac{1}{2}$[2]	
⊙ 1$\frac{1}{2}$[9]	41	31	02.87	88.5	90	36	04.76	110.4	246	43	46	66	44	59	△ School	2784.9
									292	58	58	113	00	41	◬ Rock Island	3888.2
⊙ 1$\frac{1}{2}$[0]	41	31	42.63	1315.2	90	32	16.00	370.9	87	21	44	267	20	26	△ School	2748.3
									27	16	13	207	15	57	△ Arsenal Stack	1238.3
									81	59	55				△ Court House	
⊙ 1$\frac{1}{2}$[1]	41	30	53.05	1636.6	90	29	03.17	73.5	165	07	14	345	07	07	⊡ 1$\frac{1}{2}$[1]	1022.5
									141	11	58	321	11	34	◬ Gilbertown	
⊙ 1$\frac{1}{2}$[1]	41	31	25.08	773.7	90	29	14.50	336.2	2	11	04	182	11	02	◬ Race Track	
⊙ 1$\frac{1}{2}$[2]	41	32	42.74	1318.6	90	25	01.75	40.6	129	23	02	309	22	18	⊡ 1$\frac{1}{2}$[3]	2003.8
									157	19	15	337	18	43	◬ Valley City	2906.4
⊙ 1$\frac{1}{2}$[3]	41	33	23.94	738.6	90	26	08.58	198.9	132	18	45	312	18	29	⊡ 1$\frac{1}{2}$[2]	743.4
									196	52	26	16	52	38	◬ Valley City	1473.8
									334	46	51	154	47	26	◬ Watertown	2810.2
⊙ 1$\frac{1}{2}$[2]	41	33	40.16	1239.0	90	26	32.30	748.4	227	02	46	47	03	14	◬ Valley City	1335.5
									330	07	53	150	08	43	◬ Watertown	3508.5
⊙ 1$\frac{1}{2}$[3]	41	34	13.76	424.5	90	22	53.15	1231.5	188	26	51	8	26	56	⊡ 1$\frac{1}{2}$[3]	1200.4
									108	07	35	288	06	33	◬ Fulton	2263.4
									209	58	57	29	59	21	◬ Sycamore	1713.2
									48	14	27	228	14	23	◬ Crab Island	212.9
									88	14	46	268	12	49	◬ Valley City	
⊙ 1$\frac{1}{2}$[3]	41	34	52.25	1611.9	90	22	45.54	1054.9	14	09	17	194	09	07	◬ Crab Island	1370.8
									299	49	04	119	49	36	◬ Lower Base	1276.5

DESCRIPTIONS OF SECONDARY TRIANGULATION STATIONS FROM PORT LOUISA, IOWA, TO GORDONS FERRY, IOWA, 1892.

Hardtimes is marked by tile and pipe on Iowa side on bluffs west of Muscatine Slough, and about 5 miles below Muscatine, Iowa. Station is 1¼ miles below schoolhouse on bluff side of wagon road; 300 meters below creek, where two houses and two large barns stand; three-fourths mile below a lone pine standing on side of bluff; 30 meters east of a wire fence along top of hill. Trees blazed with triangles; 8-inch black oak=255° 14.4 meters; 6-inch red oak = 120° 2.9 meters; 5-inch red oak = 22° 15.7 meters.

Fruitland: Tile and pipe on Iowa side, 6 miles below Muscatine, Iowa; 4 meters north of fence which runs west from river at a point 1,100 meters above Beatty's house; 590 meters west of levee, and 140 meters (paced) west from fence corner at crest of ridge. Elevation of pipe, 609.11; tile, 605.11 feet above Memphis datum.

Muscatine is center of town on residence of Mrs. Cora Weed, Muscatine, Iowa.

Carruthers: Tile and pipe on Illinois side on apex of hill three-fourths mile back of main road between Muscatine and New Boston; one-fourth mile below Copper Creek; 7 miles from Muscatine by road; on land of Mrs. Rachael Ann Carruthers.

Campbell: Tile and pipe on Illinois side in road on apex of bluff, 3 miles east of east end of Muscatine Bridge, just opposite house of Robert Campbell, and one-fourth mile west of residence of Dan M. Foster.

Hair: Tile and pipe on highest point of hill on land of Judge Hair, 3 miles above Muscatine, Iowa; one-fourth mile north of railroad, and about three-fourths mile above head of Island 334; 42 meters east of north and south fence running over hill opposite east end of race track at foot of bluff; 65 meters west of orchard on same hill, and one-half mile below schoolhouse.

Hershey: Tile and pipe on Illinois side on top of bluff opposite head of Island 331, one-fourth mile east of ravine, and about 20 meters from wagon road running up bluff from the ravine.

Wyoming: Tile and pipe on Iowa side on second hill north of railroad; about 1 mile below Fairport, Iowa; 300 meters below railroad bridge 73, ¾ miles above Wyoming hill; near head of ravine, on land of Hincky heirs.

Martin: Tile and pipe on Illinois side, at crest of bluff opposite foot of Andalusia Island; 9 meters north of an east and west fence, and 150 meters south of road at foot of bluff. Trees blazed with triangles; 10-inch black oak, 289° 5.6 meters; 23-inch white oak, 95° 3.1 meters; 14-inch white oak, 166° 14.0 meters.

Fairport: Tile and pipe on Iowa side on crest of hill, three-fourths mile above railroad station, Fairport; about 600 meters above upper limits of Fairport, 400 meters from river, 150 meters from railroad track, opposite a point midway between the second and third railroad bridges above Fairport, and on land of George Smith. Trees blazed with triangles; 10-inch white oak, 225° 18 meters; 10-inch white oak, 30° 8.5 meters; 5-inch white oak, 150° 10.5 meters. Bearings magnetic.

Hays: Tile and pipe on Illinois side on high knoll in grass field, 400 meters from river, and 300 meters north of large stock barn of Col. Hays; at edge of brush at crest of hill, 43 meters north of fence, and opposite middle of tow head in Andalusia Slough.

Lowry: Tile and pipe on Iowa side in yard of Wm. E. Lowry, 1 meter north and 1 meter east of northwest corner of orchard fence, and 25 meters east of east side of Lowry's house, which is a little above railroad bridge 57.

Dean's Point: Tile and pipe on Illinois side on wooded bluff point, just back of abandoned clearing at foot of bluff (only clearing in vicinity), and 12 meters back of highest point of bluff. Station is opposite a point 1 mile above Montpelier, Iowa trees blazed with triangles; 5-inch poplar, 150° 5 meters; 9-inch black oak, 315° 8.5 meters; 5-inch black oak, 8° 4.5 meters.

Perry: Tile and pipe on Iowa side, about one-half mile north from river bank, on level surface at top of hill about 300 meters north of railroad; 150 meters east of section-line fence which crosses railroad at third telegraph pole east of bridge 40; about 80 meters northeast of clump of evergreens at old graveyard, and on land of Mrs. Morehead.

Andalusia: Tile and pipe on Illinois side on land of Mrs. Paul Shaw, about one-half mile below limits of Andalusia, Ill., on side of bluff about 150 meters south of main road and 50 meters east of fence.

Buffalo: Tile and pipe on Iowa side about 1 mile back from Buffalo, Iowa, at the jog in north and south lane. Elevation of pipe, 719.54; tile, 715.54 above Memphis datum.

Bean: Tile and pipe on Illinois side on land of Mr. Haas, 50 feet south of south line of J. L. Bean's property; is on prominent hill about 2 miles east of Andalusia, Ill; hill is bare of timber, and a large poplar bears about E.S.E. 810 feet.

△ Anderson: Tile and pipe on Iowa side on top of bluff, one-fourth of a mile directly back from Fairview schoolhouse, at roadside 3 meters south of fence on north side of road, 100 meters west of fence corner on north side of road, and 300 meters east of large red barn which stands on north side of road opposite a dwelling house.

△ Kane: Tile and pipe on Illinois side on land of Robert Kane, on crest of bluff 3¼ miles below Milan, Ill., near an east and west fence, and 15 meters east of an old hedge row running north and south.

△ Beatty: Tile and pipe in southwestern Rock Island, on land owned by the Davenport heirs and leased to one Beatty; is 302 meters west of Ninth street, 188 meters north of fence at race track, and about midway between slough and top of slope in grass field. Station is on line with △ school and a prominent square-topped tower in Rock Island.

△ Davenport: Tile and pipe on top of bluff in West Davenport on property of Dr. Bickford, 10 meters west of old barn, 100 meters north of street, 300 meters below where main line of Chicago, Rock Island and Pacific Railroad enters bluffs.

△ School: Is marked on floor in cupola of high school building in Davenport, Iowa. It is 53° 50′ 1.305 meters from center of tower.

△ Rock Island: Tile and pipe on wooded knoll between Twenty-ninth and Thirtieth streets in Rock Island, Ill., on land of C. F. Lynde; opposite and about 40 meters south of Huber's brewery.

△ Rock Island Astronomical Post: Stone post 24 inches long by 18 inches in width projecting 15 inches above ground, on lower end of Arsenal Island, 300 meters above the arsenal building near end of bridge, 150 meters above fence at guardhouse, and 20 meters from river. Geodetic point is marked by cross in top of stone. Elevation, 574.15 (precise levels).

△ Arsenal Tower is point on top of arsenal side of tower on arsenal building 1865A at foot of Rock Island; in center of coping 4.04 meters from extreme southeast end of coping and 6.43 meters from northwest end of coping.

△ McClellan: Tile and pipe on Iowa side on site of old Camp McClellan, 400 meters from the river, on land of William Grummoll, just above city limits of Davenport.

△ Moline: Tile and pipe on wooded hill in Moline, Ill., diagonally opposite the Fourth street school; almost in line with the prolongation of Fifth avenue.

△ Gilberttown: Tile and pipe on Iowa side 1 meter west of fence on west side of road which runs north from road at foot of bluff about one-quarter mile above the Gilberttown stone schoolhouse. Station is on second hill, 25 meters north of fence corner, and about 80 meters north of dwelling house.

△ Race Track: Tile and pipe in small grove at top of prominent bluff back of race-track, 1 mile above Moline, Ill.; on first hill above cemetery.

△ Crow: Tile and pipe on Iowa side, on top of bluff in middle of grass field, almost in line with road running from river to foot of bluff opposite middle of Campbell's Island.

△ Watertown: Tile and pipe on Illinois side, 150 meters back from schoolhouse at Watertown, Ill.; on top of bluff, 40 meters above a cultivated field and 20 meters back from crest of bluff; to fence corner 355° 43 meters; to small, lone crab-apple tree 165° 15 meters.

△ Hampton: Tile and pipe on Illinois side, on top of bluff, 100 meters north of road running east past the Methodist church in the lower part of Hampton, Ill.; 15 meters east of fence inclosing garden at house.

△ Valley City: Tile and pipe on Iowa side, on top of bluff, 210° 150 meters from Pleasant Valley brick schoolhouse. In grass field on land of S. S. Blackman, 11 meters north of fence and 10 meters west of line fence. Station is on line with Hampton business houses and head of Island 402.

△ Fulton: Tile and pipe on Iowa side, on top of bluff opposite foot of Fulton's Island, and 300 meters above old mill at river bank. At roadside, 1 meter northwest of fence on river side of road, 180 meters above jog in road at dwelling house, and 20 meters above fence corner at lower end of grove on opposite side of road.

△ Crab Island: Tile and pipe on Illinois side, on land of G. W. Bowles; on top of hill in grass and scattering timber, 60 meters due west from fence corner, on top of hill, and 100 meters back of Chicago, Milwaukee and St. Paul Railroad.

△ Sycamore: Tile and pipe on Iowa side on flat high ground half way up hill, 200 meters north of river; in cultivated field near edge of timber, 8 meters east of west edge of field, and 10 meters south from north edge of field one-half mile above schoolhouse, and 2 miles below Le Claire, Iowa.

△ Lower Base: Tile and pipe at west end of Rapids City base line; on north side of Chicago, Milwaukee and St. Paul Railroad track, at foot of dump 1¼ miles below Rapids City, and 153 meters below bridge $\frac{E}{486}$. Elevation, pipe, 587.31; tile, 583.29 feet above Memphis datum.

△ Upper Base: Tile and pipe at east end of Rapids City base line; on south side of railroad track at top of cut, opposite brick dwelling house of Mr. Shafer; oppo-

site third telegraph pole below wagon road and sixth pole below depot. Elevation of pipe, 600.89; tile, 596.87 feet above Memphis datum.

△ Le Claire: Tile and pipe on Iowa side on flat ground at top of hill in open field, directly back of old mill on river bank, 1 mile below Le Claire, Iowa; 80 meters back from crest of hill, 80 meters west of rail fence, and 40 meters south of fence at road side.

△ Rapids City: Tile and pipe on Illinois side at highest point of bare hill, one-half mile above Rapids City, Ill; directly back from an old abandoned frame house, and 300 meters below a prominent bare bluff point.

△ Le Boone: Tile and pipe on Iowa side in open spot in oak grove on second ridge, 100 meters north of road running back from river one block above ferry landing in upper part of Le Claire, Iowa. Trees blazed with triangles: 16-inch white oak, 180° 7.5 meters; 12-inch white oak, 25° 12.5 meters; 12-inch red oak, 330° 10 meters.

△ Port Byron: Tile and pipe on Illinois side on top of hill in upper part of Port Byron, Ill., about 200 meters back of second street and 13 meters north of road running back from river one block above steamboat warehouse.

△ Hopson: Tile and pipe on Iowa side on top of bluff point, 200 meters below a tow head near right bank of river, and two miles above Le Claire, Iowa; 15 meters north of fence at north edge of grove and 25 meters west of fence corner.

△ Woodward: Tile and pipe on Illinois side, on sandy knoll, one-half mile back from crest of bluff, and 2½ miles above Port Byron, Ill.; 90 meters west of lane leading south from county road to residence of Mr. Woodward; 200 meters northwest of house, and in center of small inclosed lot west of lane.

△ Princeton: Tile and pipe on Iowa side on top of hill in cultivated field one-half mile back from river, and 65 meters south of wagon road which runs west from lower end of Princeton, Iowa, at the brick warehouse on river bank; 26 meters west of fence and 150 meters southeast of cemetery. Station is due south from east end of barn on north side of the road.

△ Cordova: Tile and pipe on land of Jim Armstrong, and back of his house, on hill 400 meters back of Johnson's limekilns. Elevation of pipe, 704.85; tile, 700.83 feet above Memphis datum.

△ Wapsie: Tile and pipe on Iowa side in Wapsie bottoms, 3 miles northwest of Princeton, Iowa; one-fourth mile east of Clinton wagon road and one-fourth mile west of another wagon road; 2 meters east of fence at jog; one-fourth mile north of lane and 100 meters south of section corner at hedge.

△ Evergreen: Tile and pipe on Illinois side on south side of wagon road running east from river, opposite mouth of Wapsipinicon; about 1 mile east from river, 4 meters north of fence on south side of road, and 20 meters east of Chicago, Milwaukee and St. Paul Railroad.

△ Rocks: Tile and bench-mark pipe on Illinois side on highest grassy knoll on land of John Williamson, 5 miles east of Cordova, Ill. From ledges of rock outcropping in the neighborhood, it is called the "Rocks."

△ Marais D'Osier: Bench-mark tile and pipe on Illinois side on very high grassy knoll, 3 miles below Albany, where the Marais D'Osier comes close to foot of bluffs; on land of Mr. Grady, of Clinton, Iowa, near residence of Mr. Hugh Farrell; on prolongation of wagon road running south along foot of bluffs below Marais D'Osier Bridge.

△ Camanche: Tile and pipe on Iowa side on top of hill in grass field one-fourth mile north of road running west from Camanche, Iowa, in prolongation of Chicago street; on Benning estate, 100 meters west of one fence, 30 meters south of another, and about one-half mile northwest of Chicago and Northwestern Railroad main line.

△ Albany: Bench-mark tile and pipe on land of M. Freak, on apex of knoll back of and near his house and in his garden at Albany, Ill.

△ Clinton: Center of finial of cupola on school house on Eleventh avenue, between Sixth and Seventh streets, Clinton, Iowa.

△ Ferris: Tile and pipe on Illinois side on sand ridge 8 miles east of river, one-half mile north of road running east from Clinton bridges, 2 miles south of road running east out of Fulton, and one-half mile east of north and south road which leaves Fulton road just east of bridge over creek 2 miles east of Fulton. Station is in open spot in small oak timber and near south end of sand ridge.

△ Lyons: Tile and pipe on bluff point one-half mile above upper sawmills in Lyons, Iowa; in line of fence about 15 meters back from crest of bluff, and 200 meters north of a dwelling house.

△ Jack Green: Tile and pipe on Illinois side on property of Jack Green; on mound on top of bluff, 10 miles northeast of Fulton, Ill., 3 miles north of where Fulton wagon road enters bluffs and three-fourths of a mile above school house in district No. 1. Two small pines stand near top of mound 5 meters west and north of the station. The foot of bluff where the station stands is at edge of wagon road.

Below, the bluffs are farther from the road. Trees blazed with triangles: 12-inch black oak, 325° 5 meters; 8-inch black oak, 248° 5 meters.

Elk River: Tile and pipe on Iowa side on top of bluff about 1 mile north of mouth of Elk River and back of railroad bridge 512, 200 meters back from timber at crest of bluff, 80 meters south of head of small ravine, and 70 meters southeast of fence corner at farm house.

Dyson: Tile and pipe on Illinois side on crest of high wooded bluff, in front of timber, on property of Mr. Dyson, about 100 meters back of bluff road, 400 meters above a long row of elms along road across bottom 400 meters below a stone dwelling house on bluff side of road, and about 5 miles below the point where the Chicago, Burlington and Northern Railroad enters bluffs.

Sabula: Tile and pipe on Iowa side on top of bluff in clover field, 40 meters back from crest of bluff, 40 meters south of fence at south side of orchard which is just south of residence of R. A. Schroeder; about 1 mile below Sabula, Iowa, on property of Lou Eskelson.

Bristol: Tile and pipe on Illinois side on top of ridge east of bluff road, 200 meters below crossing under Chicago, Burlington and Northern, where it enters bluffs; on land of Widow Bristol, 5 meters east of fence.

Savanna: Tile and pipe on Illinois side about 1¼ miles north of Savanna, Ill.; 1 meter south of fence on south side of road, and 15 meters east of fence corner at junction of roads.

Lainsville: Tile and pipe on Iowa side on top of mound at top of bluffs in pasture on property of William F. Marr; 70 meters west of fence between pasture and small cultivated field which lies between two ravines which join opposite the station at railroad bridge, $\frac{K}{12}$ three-fourths mile above Lainsville railroad station.

Miller: Tile and pipe on Illinois side on brow of bluff, 4 miles above Savanna, Ill., 50 meters east of wagon road and 200 meters east of railroad; on property of Mr. Fisher, whose residence is one-half mile north. Trees blazed with triangles: 14-inch black oak, 235° 6 meters; 18-inch black oak, 145° 11 meters.

Apple River: Tile and pipe on Illinois side on highest point of sand ridge, three-fourths mile above mouth of Apple River; in oak timber 50 meters from river bank, 600 meters below head of island 267, and 100 meters below dyke.

Green Island: Tile and pipe on Iowa side on side of bluff at top of rock ledge, 3 meters back from crest of bluff; 270 meters north of wire fence at top of bluff; 100 meters northwest of small shed east of railroad track. Station is nearly 2 miles north of Green Island, Iowa, and opposite about the twentieth telegraph pole above the Maquoketa Bridge.

Hanover: Tile and pipe at Chicago, Burlington and Northern Railroad station, Hanover, Ill.; 2 meters east of fence at west side of right of way, and about 50 meters north of depot.

Harrington: Tile and pipe on Iowa side on wooded point opposite foot of Island 249, on land of Joe Harrington.

Blanding: Tile and pipe on Illinois side on top of bluff one-half mile below railroad station Blanding, and one-fourth mile above road crossing railroad; 30 meters from top of rock ledge and 8 meters from edge of woods.

Rogers: Tile and pipe on Iowa side on high ridge one-fourth mile east of the bluffs and one-fourth mile west of the river, 8 meters west from east crest of ridge; in open pasture, 200 meters southwest of the brick dwelling house of Mr. Rogers, 1 mile north of Bellevue, Iowa. Distance, 7 meters; azimuth, 10° to a double black oak. Elevation of pipe, 817.96; tile, 813.96 feet above Memphis datum.

Wise: Tile and pipe on Illinois side on top of bluff in open meadow one-fourth mile back from river and 20 meters north of sink hole; on property of Mrs. Wise.

Smith: Tile and pipe on Iowa side on top of bluff one-half mile back from river in long narrow open field between trees; three-fourths mile above Smith's siding.

Horseshoe is near the Coast-Survey station of the same name. Geodetic point is center of hole drilled in top of exposed rock ledge. A pipe 1 foot long and 4 inches diameter with the usual cap is centered over this mark and cemented to the rock. Station is 1 mile southeast of Galena, Ill., at northwest end of Horseshoe Mound, on top of exposed ledge of natural rock 2¼ meters wide and 5 meters from south end of ledge. Station is about 100 meters south of road running east from Galena and is on property of Samuel Roberts.

Gordon's Ferry: Tile and pipe on Iowa side on property of John Schenk, about 3 miles north of Gordon's Ferry, Iowa; on top of wooded point one-fourth mile back from river.

Sinsinnawa: Steel bolt in natural rock on Wisconsin side on highest point on wooded hill of same name, in rear of church at St. Clara's Academy, Sinsinnawa, Wis., and 20 meters westerly from a large wood cross. This station is one of the Coast-Survey points.

APPENDIX 3 B.

REPORT OF MR. A. T. MORROW, ASSISTANT ENGINEER, IN CHARGE OF TOPOGRAPHICAL PARTY FOR SEASON OF 1892.

ST. LOUIS, MO., *November 23, 1892.*

CAPTAIN: I have the honor to submit the following report on the operations of the topographical party which has been under my charge during the field season just closed:

On August 29 the steamer *Patrol* was turned over to me at Quincy, Ill., together with a small party then on board. At that point I took in tow the quarter boat *Illinois* and proceeded to Hannibal, Mo., where I spent the remaining days of August in renovating the steamer and quarter boat.

On September 1 the rest of my assistants and a number of men reported for duty, and at the same time I received an outfit of instruments and a supply of subsistence stores from St. Louis.

On September 2 the field work was begun at the Hannibal Bridge (stone line 94) with a party composed as follows: Assistant Engineer A. T. Morrow in charge; Messrs. W. G. Comber, George H. French, E. L. Harman, Horace Dunaway, E. J. Thomas, C. L. Ockerson, and O. N. Axtell, topography; A. O. Wheeler and T. G. Ray, ordinary levels; T. C. Hockridge and L. D. Cabanne, hydrography; M. I. Powers and H. C. Winchell, computations and platting. In addition to these there were the officers and crew of the steamer and a number of men, which was increased until the party numbered altogether about 63 persons.

The stage of water and the weather were favorable for the work and remained so for the entire season.

The party suffered a good deal from malaria while working on the overflowed lands, but at such times a few extra men were kept employed and the work did not suffer any serious delay.

On November 10 the work was completed to stone line 114, 10 miles above Keokuk, and was there discontinued. The quarter boat *Illinois* was laid up at Keokuk and the steamer *Patrol* brought back to St. Louis and turned over to Assistant Engineer J. A. Ockerson, there still remaining on board a small party which had been retained for work on the lower river.

With a few exceptions, which will be noticed, the fieldwork has been carried on in accordance with the printed instructions.

From Hannibal to Keokuk the secondary stations are far apart, and in most instances at a distance from the river. It therefore became necessary to carry a complete system of tertiary triangulation over the whole work. A 50-meter steel tape had been provided for the measurement of tertiary bases and proved to be a great aid to the work, and tertiary bases were measured at intervals of about 5 miles as far as Keokuk, where secondary lines were available. The azimuth and coördinates, however, were checked on secondary points at Quincy, La Grange, Canton, and Warsaw, and the azimuth was checked at secondary station Heather, about halfway between Hannibal and Quincy. An appended tabulation will show the discrepancies at these various points of connection. The entire number of tertiary triangles was 260. The longest tertiary line was 3,478 meters; the average tertiary was 1,297 meters; the shortest 485 meters.

A line of ordinary levels was carried along each bank of the river to form a basis for topographical work. These two lines were checked on each other every 3 miles by "river crossings" and as frequently as possible by connection with the precise bench marks previously established in this region. A table showing the results of these connections is appended hereto. Especial care was taken to connect with all local bench marks, water gauges, monuments of surveys, and all authentic high-water marks.

Soundings were taken in the customary manner from a cutter and located by sextant angles, section lines being sounded about every 250 meters, followed by a channel line through the deepest water found on the sections. At the Des Moines Rapids, however, that method did not seem practicable, as the water was too shallow and swift to admit of sounding from the cutter and a skiff would not carry the necessary observers to locate the soundings by sextant. A skiff was therefore used and observers placed on shore with transits and the course of the sounding skiff guided by two flagmen on opposite sides of the river. All the points occupied by the observers were afterwards located by tertiary triangulation.

Lines were thus sounded across the river at points about 200 meters apart, and above the canal three longitudinal lines were run in the channel to the extremity of the work. Total number of soundings for the season, 25,490; total number of sextant angles read, 10,674.

In the topographical work especial attention was given to instrumental checks, and all stadia lines were begun and ended either on points of triangulation or on

points of other stadia lines, thus giving checks on azimuths, distances, and elevations. An attempt was made to improve the method of sketching which has heretofore been in practice. For this purpose Assistant Engineer J. A. Ockerson sent to the field a semicircular transparent pivot protractor-with scale to be used in plotting stadia stakes and important points of topography, prior to the operation of sketching. Mr. W. G. Comber experimented with this protractor and soon found that it could not be used to advantage in the note books, as the protractor could not be kept in place on the loose leaves, and the size of the page was too limited to admit of the revolution of the protractor. A small sketching board and a sheet of computing paper about four times the size of a page of the note book were then substituted.

These proved satisfactory and the plan was soon after adopted by several other topographers, and in every case with satisfactory results. The little time lost in platting was more than made up by the increased facility with which the sketching could be done and by the readiness with which the topographer could lay out his work by the aid of an extended and accurate sketch. It does not seem practicable to transfer the sketches to the plats during the season of fieldwork, and a more comprehensive and accurate method seems desirable in order that the sketches may be laid over to be transferred in the office.

I am of the opinion that this method or some modification of it would be an improvement over the method heretofore practiced. These detached sketches, when they are finished or when they have been transferred, can be folded and pasted into the note books, thus becoming as completely a part of the permanent record as if they had been made on the pages of the note book.

In accordance with the suggestion of Assistant Engineer J. A. Ockerson, the party was supplied this season with field sheets of tracing linen instead of paper field sheets as heretofore. Plats made upon these can be transferred directly to the detail charts without the additional labor and the increased inaccuracies of transferring by tracings. To what extent these advantages will be offset by the difficulty of making and retaining the details of the plats on the smooth surface of the linen, can not be determined until the work shall have made further progress.

Owing to a large number of islands, several cities and towns and a large extent of bottom land filled with sloughs, the amount of topographical work required for a mile of river has been unusually large, as will be seen by the following figures: Number of miles of levees surveyed outside of limit of topography, 10; number of miles of lakes, sloughs, and rivers outside the ordinary limit of topography, 94; number of miles of bluff line, 78; number of square miles of topography, 197¼. The entire distance covered by the work of the season is 60 miles by river, and the total number of working days 59, making a little more than an average of 1 mile of river per working day.

The field season has been so short that the party was not more than thoroughly organized when the work was discontinued, and as the part of the river surveyed has been a difficult one, it seems to me that the work of the party has not been unsatisfactory, a result which is due much more to the efficient services of my several assistants than to any efforts of my own.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.

Table showing discrepancies in azimuth between tertiary and secondary triangulation.

Stations.	Tertiary azimuth.			Secondary azimuth.			Discrepancy.		Number of triangles.	Closure per triangle.
	°	′	″	°	′	″	′	″		″
△ Hannibal to △ Heather	210	12	54	210	11	47	1	07	26	2.57
△ Heather to △ Quincy	324	02	25	324	00	35	1	50	30	3.66
△ Quincy to △ La Grange	242	30	40	242	30	46		06	27	0.22
△ La Grange to △ Canton Univ	236	51	14	236	50	47		27	14	1.92
△ Canton Univ. to △ Warsaw	137	45	42	137	45	30		12	45	0.26
△ Warsaw to △ Rapids	214	39	52	214	40	05		13	13	1.00
△ Rapids to B. M. 1¼	84	53	48	84	53	54		06	5	1.20
B. M 1¼ to Sandusky	113	21	13	113	20	42		31	6	5.16
△ Sandusky to △ Edwards	21	31	19	21	32	12		53	4	13.25
△ Edwards to ⊡ B. M. 1¼	193	53	40	193	53	24		16	5	3.20
Mean								34	175	3.24

Table showing discrepancies between computed and measured bases and secondary lines.

Distance.	Number of triangles.	Computed base.	Measured base.	Discrepancy.	Rates.
Miles.		*Meters.*	*Meters.*	*Meters.*	
4	10	942.37	942.22	.15	1: 6,281
6	14	1,161.89	1,161.43	.46	1: 2,525
2	6	693.95	693.98	.03	1: 23,133
4	12	788.93	788.71	.22	1: 3,585
4	11	613.57	613.70	.13	1: 4,721
8	23	852.17	852.27	.10	1: 8,523
5	13	547.66	547.33	.33	1: 1,658
5	19	599.64	599.42	.22	1: 2,724
4	12	1,440.35	1,439.46	.89	1: 1,600
4	11	1,031.23	1,031.30	.07	1: 14,733
9	16	1,570.09	1,569.80	.29	1: 5,413
4	20	1,279.67	1,279.52	.15	1: 8,530
4	9	1,261.49	1,261.52	.03	1:42,050
60					

Average closure, 1: 9,652 (regardless of length of run).

Discrepancy between precise and ordinary levels.

Between P. B. Ms.	Distance.	Error.	Leveled by—	Between P. B. Ms.	Distance.	Error.	Leveled by—
	Miles.				*Miles.*		
No. 16 and 14	11½	0.04	F. G. Ray.	No. 8 and 5	16	0.17	F. G. Ray.
No. 14 and 12	6½	0.03	Do.	No. 5 and 2	5	0.15	Do.
No. 12 and 56 McK.	8½	0.17	Do.	No. 2 and 3	½	0.00	Do.
No. 56 McK. and 10.	1	0.	Do.	No. 2 and 1	¾	0.00	Do.
No. 10 and 8	5	0.11	Do.	No. 1 and 1	2¾	0.03	Do.
No. 8 and 9	½	0.00	Do.	No. 1 and 2	5¼	0.11	Do.

Discrepancies between right and left bank levels.

River crossing at—	Distance.	Discrepancy.	River crossing at—	Distance.	Discrepancy.
	Miles.			*Miles.*	
Stone line 95	3	0.145	Stone line 105	3	0.16
96	3	0.100	106	3	0.00
97	3	0.09	107	3	0.01
98	3	0.05	109	6	0.10
99	3	0.07	110	3	0.14
100	3	0.15	111	3	0.18
101	3	0.13	113	6	0.02
103	6	0.23	114	3	0.13
104	3	0.10			

Descriptions and elevations of high-water marks leveled to in season of 1892.

Description.	Year.	Elevations.
On water gauge on Quincy Railroad bridge	1888	485.23
On northwest corner ◇ Jo Warehouse, La Grange, Mo	1892	487.63
On northeast corner of the "Blackwood," La Grange, Mo	1888	488.61
On southeast corner of the "Blackwood," La Grange, Mo	1851	490.93
On northeast corner of Buschman's feed mill, Canton, Mo	1888	491.89
On northeast corner of Palmer's boarding-house, Alexandria, Mo	1888	500.89
Do	1881	500.80
On southeast corner of ◇Jo◇ Warehouse, Keokuk, Iowa	1892	503.67
On water gauge on lower lock of D. M. R. Canal	1851	505.61
Do	1888	504.29
Do	1881	503.59
On water gauge on middle lock of D. M. R. Canal (in canal)	1891	505.64
Do	1888	504.34
Do	1881	503.64
On water gauge in sluice way at middle lock (in rapids)	1888	506.65
On water gauge on upper lock of D. M. R. Canal	1888	515.74
Do	1881	515.06
Tellico Mills, Quincy, Ill	1851	487.50
Do	1888	484.58
Do	1881	484.09
On tree opposite foot of Island No. 432	1892	482.24
Vicinity of Warsaw, Ill	1888	502.08
On small culvert 4,590 meters above Keokuk bridge, on left bank	1885	505.96
On small culvert 4,060 meters above Keokuk bridge, on left bank, and 300 meters north of Ⓐ rapids	1888	506.08

APPENDIX 3 C.

REPORT OF ASSISTANT ENGINEER A. T. MORROW ON TERTIARY TRIANGULATION AND STONE LINES FROM DONALDSONVILLE TO HEAD OF PASSES, AND PRECISE LEVELS FROM NEW ORLEANS TO HEAD OF PASSES, NOVEMBER, 1892, TO MARCH, 1893.

ST. LOUIS, *April 10, 1893.*

CAPTAIN: I have the honor to submit the following report on the work done by the party which operated under my charge on the lower river during the past winter.

On November 17 the steamer *Patrol* left St. Louis under charge of Assistant Engineer J. A. Ockerson, who was engaged during the down-river trip in inspecting and repairing gauges and bulletins. On December 8, when the steamer had reached Donaldsonville, La., I joined the party and began work with a party composed as follows: A. T. Morrow in charge, with G. H. French, T. C. Hockridge, O. N. Axtell and A. O. Wheeler, assistants. There were also the crew of the steamer and 13 additional men. The work in view consisted of placing the bench marks on "stone lines" from Donaldsonville to the Head of the Passes and connecting them with the remaining marks of the old Coast Survey triangulation. This work was continued down the river till the city of New Orleans was reached on January 12. At that point the party was joined by precise-level men J. A. Paige and E. J. Thomas, recorder W. S. Williams, and twe precise-level rodmen.

Two additional men were employed, a barge to carry coal was borrowed from Capt. Millis, a supply of bench marks and stones were taken on board, and on January 17 the steamer left New Orleans bound for the Head of the Passes, where the work was to be taken up in order to complete the lower portions of the river before the season of high water. At Fort Jackson the steamer was delayed two days by storms, and reached South Pass on the morning of January 20. The work from the Head of the Passes to New Orleans consisted of placing and locating bench marks and running a line of precise levels between these two points, and was prosecuted with a party composed as follows: A. T. Morrow, in charge; J. A. Paige and E. J. Thomas, precise level men, with recorders A. O. Wheeler and W. S. Williams; G. H. French, tertiary angles; T. C. Hockridge, bench marks, and O. N. Axtell, computations.

The work progressed without any serious delay until March 15, when the precise levels were closed on the precise bench marks at New Orleans and the work of placing and locating bench marks carried to the lower limit of the work of the early part of the season. On March 16 I discharged the men hired at New Orleans, placed the steamer, with the regular crew and three extra men, under the charge of T. C. Hockridge as master, with orders to proceed to St. Louis, and with the remainder of party, seventeen in number, I returned to St. Louis.

During the entire season the weather was, in the main, favorable, and no trouble was experienced from high water, except during the last two weeks of the season.

Tertiary triangulation.—At nearly all points enough of the Coast Survey triangulation stations remained to furnish good connections for the system of tertiary triangulation, which was carried along to locate the various bench marks of the survey. Of the 120 Coast Survey stations looked for 68 were found, and these were pretty fairly distributed, except on the stretch of river below Fort Jackson, where it became necessary to make a run of 18 miles between consecutive points of connection.

On this long stretch, however, the shores were flat and on one side mostly open, so that I was enabled to "chain" about half the distance with a steel tape, and the rest of the distance was favorable for triangulation, so that it is believed that the locations of the intermediate points are entirely reliable. During the entire season a good deal of difficulty was experienced in procuring reliable azimuths at the several Coast Survey stations on account of trees, buildings, and levees, which cut off the lines of sight between the consecutive points. For this reason it became necessary often to carry azimuth for long distances, but generally the coördinates could be checked at points sufficiently close to insure good results.

The atmospheric conditions were often unfavorable for observing angles, and it often became necessary to locate tertiary flags in unfavorable positions, such as on mud bars, tops of logs, stumps, docks, or buildings, and for these reasons the triangles did not always close with as much accuracy as could have been desired, but as the country was flat it was practicable to measure frequent tertiary bases, and it was considered more economical and productive of better results to devote less time to the determination of angles and give more attention to the measurement of tertiary bases than is usual in work of this kind.

The 50-meter steel tape, with which the party was provided, proved very serviceable for this work and was brought into almost daily use during the whole progress of the work. Besides the regular tertiary bases so measured there were check distances chained with a 20-meter chain, using ordinary chaining pins, but in the soft, wet ground of the region these determinations did not prove very satisfactory and in almost all instances were used for checks only. In a table which, is appended hereto, giving results of checks on tertiary triangulation, distances of this character are explained in a footnote as being used for checks only, as such determinations were used to detect mistakes in computations or other parts of the work, but did not enter the computations and thereby affect the general results of the work. As an illustration of the inexactness of ordinary chaining I have appended a small table showing the results of measurements of the same lines by tape and by chain. These measurements by tape and by chain were made by different parties, but on the same day. The measurements by tape were made with much care, a spring balance was used to insure uniform tension, and the extremities of each tape length were marked by a tack driven in the top of a stake set for the purpose. The marking of the chain lengths was by ordinary chaining pins, and no more than ordinary care was taken in the work, as the determinations were intended only for check on the work of the tape. The ground on nearly all of these lines was soft, but did not differ materially in that respect from most of the ground on which the chain was used during the general progress of the work. It is, therefore, probable that many of the discrepancies shown between measurements by chain and by computed distances, which were based generally on tape measurements, were due to inaccuracies of chaining rather than to defects in the tertiary triangulation.

As the ultimate object of the tertiary work was to determine the correct geographical positions of the various bench marks, perhaps a better test of the accuracy of the work is shown by the appended table, giving the discrepancies between the tertiary and secondary coördinates in the several runs from one secondary station to another.

Besides the permanent bench marks, a number of conspicuous objects have been located, and nearly all the intermediate tertiary points have been marked by stakes and their positions described, so that many of them will be available for connection for one or two years.

There were, all together, 502 tertiary triangles used during the season's work.

Bench marks.—In view of the lack of permanence that has attended many of the bench marks of former years, I have endeavored to keep steadily and prominently in view the importance of selecting permanent positions for the marks which we have established. For this purpose they have as often as practicable been placed by the sides of roadways and land lines and as much as possible out of way of cultivation and probable improvements. Where they have been put on plantations or other private grounds they have in most cases been so placed with the knowledge and consent of the owners or occupants and with the understanding that they were placed there as permanent and valuable marks of public surveys. They have also been placed with a view to being used as points of location as well as of elevation, and with this object in view they have been located, as has been stated, by triangu-

lation, and, besides, have been occupied and pointings have been taken to various permanent and conspicuous objects in sight. Observations so taken will not only furnish effective means of recovering the points hereafter, but will supply azimuth lines for use in future surveys.

Full descriptions and sketches have been made, and it is believed that in most cases these points may be recovered many years hence, even if the surface marks shall have been removed.

On the extreme lower river some difficulty was experienced in planting the bench marks, owing to the close proximity of the water to the surface of the ground, and it often became necessary to bail water continuously from the holes while the work was being done. In these cases the tiles were well rammed down, and it is believed that they are as stable as any objects in those localities. Two bench marks placed in wet ground at Fort Jackson on the way down seemed not to have settled perceptibly in the two weeks that elapsed before our return to that place.

It is a question, however, in my mind whether any object in the vicinity of the Passes remains permanently at the same elevation—a question that will perhaps not be definitely settled until precise levels shall have been carried down again from above, after a lapse of years.

A table is given below showing number and kind of bench marks established.

Precise levels.—Two precise-level bench marks were established at the head of the Passes and connection was made with the U. S. Engineers' bench mark and two gauges. From that place precise levels were carried on the right bank to Fort Jackson and thence on the left bank to New Orleans, where they were connected with the P. B. M's of 1883, back of the city, and carried to the Coast Survey astronomical post in Lafayette Square. Much less difficulty was experienced on the wet ground of the extreme lower river than was anticipated, a line having been cleared out through the timber, where the roots of trees served as turning points and the uniform atmospheric conditions seemed to largely compensate for the difficulty of leveling over the soft ground.

Assistant Engineer Paige, who was placed in general charge of precise levels, will make a report on the results and methods of that work.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.

Table showing number and character of permanent bench marks established between Donaldsonville, La., and the Head of the Passes, during the progress of the survey of the winter of 1892 and 1893.

	Number.
Ordinary bench marks of tile and pipe	198
Secondary triangulation stations used as ordinary bench marks	6
Other marks used as ordinary bench marks	4
Total ordinary bench marks	208
Precise bench marks of tile and pipe	32
Copper bolt precise bench marks	9
Ordinary bench marks used as precise bench marks	28
Other marks used as precise bench marks	7
Total precise bench marks	76
Total bench marks of all classes	256

Table showing discrepancies in tertiary triangulation.

Stations.	Distance chained or computed.	Distance computed.	Discrepancies.	No. of triangles.	Proportionate discrepancies.
	Meters.	*Meters.*	*Meters.*		
1^{22} to 1^{23}	*791.55	791.43	.12	4	1 in 6,597
1^{52} to 1^{53}	*882.80	883.30	.50	7	1 in 1,766
1^{52} to St. James ch	762.88	763.07	.19	3	1 in 4,016
△ 25 to △ 24	952.84	953.07	.23	4	1 in 4,144
1^{16} to 1^{28}	*857.48	857.50	.02	5	1 in 47,874
△ 34 to △ 36	1175.75	1175.76	.01	5	1 in 117,575
△ 39 to ware ho. cupola	752.21	752.16	.05	5	1 in 15,045
△ 44 to △ 46	671.68	671.48	.20	2	1 in 3,358
1^{18} to 1^{28}	*852.20	852.05	.15	2	1 in 5,681
△ 44 to △ 46	671.68	671.70	.02	2	1 in 33,584
1^{32} to △ 50	*870.74	870.67	.07	2	1 in 12,439
△ 50 to △ 48	600.32	600.87	.55	3	1 in 1,092
△ 51 to 1^{28}	*1128.33	1128.17	.16	6	1 in 7,052
ⓐ St. John to St. Johns ch	1692.80	1692.30	.50	7	1 in 3,360
△ 62 to △ 60	950.47	950.38	.09	15	1 in 10,561
2^{02} to △ 67	*609.70	609.66	.04	4	1 in 15,242
2^{03} to △ 74	*1108.80	1108.36	.56	6	1 in 1,981
2^{62} to △ 73	*636.20	636.63	.43	7	1 in 1,481
2^{04} to △ 81	*861.70	862.16	.46	17	1 in 1,895
2^{04} to △ 78	*875.84	876.24	.40	17	1 in 2,189
2^{05} to △ 82	*1024.40	1024.53	.13	2	1 in 7,881
2^{05} to 2^{06}	*784.30	784.42	.12	2	1 in 6,536
△ 86 to 2^{06}	*713.37	713.86	.39	3	1 in 1,830
2^{07} to △ 95	*1005.30	1006.40	.90	4	1 in 1,117
2^{07} to △ 94	*895.14	895.26	.12	3	1 in 7,459
△ 88 to △ 90	1123.36	1123.35	.01	3	1 in 112,336
ⓐ Odier to Duseau S. H. Chy	648.10	648.20	.10	7	1 in 6,481
△ 102 to △ 105	1212.64	1212.54	.10	4	1 in 12,126
△ 104 to △ 106	*620.89	620.61	.28	2	1 in 2,218
△ 117 to 2^{11}	*822.40	822.14	.26	5	1 in 3,163
ⓐ City Park to △ 119	481.39	481.19	.20	5	1 in 2,407
2^{12} to ⓐ Com. canal	582.27	582.25	.02	4	1 in 29,113
△ Donovan No. 2 to Cubits Chy	2009.64	2009.67	.03	2	1 in 66,988
2^{34} to 2^{34}	1173.43	1173.53	.10	10	1 in 11,735
2^{32} to △ 127	800.00	800.05	.05	8	1 in 16,000
△ 131 to △ 129	1450.00	1449.04	.96	2	1 in 1,510
△ 136 to 2^{31}	806.97	806.82	.15	7	1 in 5,380
△ 143 to △ 140	955.84	956.06	.22	2	1 in 4,345
△ 152 to 2^{32}	1056.65	1056.47	.18	9	1 in 5,780
△ 170 to △ 173	686.48	686.32	.16	11	1 in 4,280
△ 189 to △ 190	721.28	721.48	.20	27	1 in 3,606
△ 197 to ⓐ Union	632.65	632.57	.08	2	1 in 7,903
△ 211 to △ 212	929.61	929.39	.22	14	1 in 4,226
△ 217 to △ 219	548.95	549.07	.12	4	1 in 4,574
2^{33} to Junior Chy	834.84	834.78	.06	9	1 in 13,914
△ 231 to △ 233	1256.10	*1254.62	1.48	4	1 in 848
2^{23} to △ 247	712.93	713.19	.26	12	1 in 3,128
△ 236 to 2^{20}	*529.12	529.30	.18	4	1 in 2,941
△ 250 to △ 252	1067.09	1067.08	.01	11	1 in 106,709
△ 256 to ⓐ Bayhi	630.70	630.66	.04	6	1 in 15,737
△ 258 to 2^{24}	727.97	728.03	.06	4	1 in 12,133
△ 264 to 2^{22}	789.73	789.66	.07	8	1 in 11,267
△ 268 to △ 267	823.21	823.26	.03	5	1 in 16,465
2^{32} to 2^{32}	*560.40	560.35	.05	6	1 in 11,208
△ 276 to 2^{21}	919.70	919.50	.20	4	1 in 4,598
△ 271 to △ 272	730.09	729.98	.11	10	1 in 6,637
△ 275 to △ 276	868.73	868.81	.08	5	1 in 10,860
△ 278 to △ 280	1057.10	1057.24	.14	5	1 in 7,551
2^{24} to 2^{21}	747.02	747.69	.03	2	1 in 24,920
△ 281 to △ 282	739.70	739.91	.21	13	1 in 3,523
△ 288 to 2^{29}	*536.43	536.43	.00	4	1 in ∞
2^{29} to △ 288	833.99	833.95	.04	5	1 in 20,850
△ 292 to △ 287	786.31	786.13	.18	11	1 in 4,368
ⓐ Magnolia to 2^{28}	1,083.09	1,083.09	.00	2	1 in ∞
△ 295 to 2^{28}	*1,040.21	1,039.72	.49	4	1 in 2,123
△ 308 to 2^{16}	985.49	985.44	.05	4	1 in 19,710
ⓐ Battle Ground, Refinery Chy	1,621.63	1,621.74	.11	2	1 in 14,742
△ 308 to Refinery Chy	986.01	986.00	.01	6	1 in 98,601
△ 307 to 2^{16}	1,214.73	1,214.61	.12	4	1 in 10,126
2^{15} to Colored Church	540.64	540.60	.04	2	1 in 13,516

* Used for check only.

Table showing discrepancies between tape and chain measurements.

Stations.	Measured with tape.	Measured with chain.	Discrepancy.	Character of ground.	Proportionate discrepancies.
	Meters.	*Meters.*	*Meters.*		
4[3] to △ 127	800.06	799.84	—.22	Soft.....	1 in 3,637
△ 129 to △ 131	1,450.05	1,449.36	—.69	....do ...	1 in 2,101
△ 131 to 2[1]	1,640.11	1,640.21	+.10	Hard ...	1 in 16,402
1[2] to △ 133	980.12	980.00	—.12	Soft.....	1 in 8,168
3[1] to △ 139	1,062.07	1,061.50	—.57	....do ...	1 in 1,863
△ 139 to △ 141	1,500.12	1,499.20	—.92	....do ...	1 in 1,631
△ 141 to △ 143	1,370.12	1,369.30	—.82	....do ...	1 in 1,671
△ 143 to 3[12]	1,472.54	1,471.80	—.74	....do ...	1 in 1,981
2[9] to △ 245	1,100.00	1,099.55	—.45	....do ...	1 in 2,444

Discrepancies between tertiary and secondary coördinates, Donaldsonville, La., to Head of Passes.

From station.	To station.	Number of triangles.	Distance.	Discrepancy in latitude.	Discrepancy in longitude.	Proportional discrepancy.
			Miles.	*Meters.*	*Meters.*	
Webre	Donalson	6	2.2	0.8	0.2	1: 4,817
St. James	St. Michael's Church.	4	1.8	0.7	0.6	1: 3,133
St. Emma	College	7	4.7	1.0	0.0	1: 7,520
Jolly	Homestead	8	4.2	1.6	0.6	1: 4,188
Do	Jolly	5	5.1	0.9	1.3	1: 5,100
White Rose	Chauf	10	2.4	1.5	0.3	1: 2,560
St. John	Reserve	7	3.9	1.1	0.4	1: 5,200
Reserve	Round-house	12	5.6	0.2	0.6	1:14,860
Kilsna	Becnar	12	4.5	0.8	0.1	1: 9,000
Bois Blanc	Avondale	3	2.1	1.0	0.1	1: 3,360
Company Canal	City Park	7	1.4	1.1	0.8	1: 1,640
Lee	St. Maurice	5	2.5	0.3	0.2	1:11,110
Orleans	Battle ground	5	1.9	0.0	0.2	1:15,200
Magnolia	Orange Grove	2	1.6	0.4	0.5	1: 4,000
Scarsdale	do	18	4.9	0.7	1.6	1: 4,360
Concessions	Scarsdale	6	2.3	0.3	1.1	1: 3,345
Do	Cedar	11	3.9	0.5	0.5	1: 8,910
Berthaud	Jesuit	8	1.4	0.6	0.3	1: 3,700
Jesuit	Bayhi	8	2.4	0.1	0.2	1:19,200
Bayhi	St. Rosalie	15	4.8	0.4	0.5	1:12,000
St. Rosalie	Woodland	22	9.5	3.9	1.3	1: 3,700
Upper Base	Union	18	5.6	0.6	0.1	1:14,930
Union	White	18	7.5	1.1	1.6	1: 6,320
White	Grand Prairie	21	8.3	0.5	0.5	1:19,000
Quarantine	Buras Church	2	0.7	0.8	0.1	1: 1,400
North	Taylor	42	18.6	1.8	1.4	1:12,940
H. P. Light	North	3	4.2	0.3	0.5	1:12,200

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana.

[Latitudes and longitudes are derived from C. and G. S. triangulation (A)'s.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	*Meters.*	° ′ ″	*Meters.*	° ′ ″	° ′ ″		*Meters.*
⊡ 18/8	30 07 14.84	457.0	90 57 35.62	953.5	14 55 52	194 55 48	⊡ 18/9	925.4
⊡ 18/2	30 06 45.81	1,410.7	90 57 44.52	1,191.8	14 34 51	194 34 46	(A) North Base	
					80 17 51		Hermitage S. H	
⊡ 18/2	30 08 53.01	1,632.4	90 56 17.39	465.4	74 33 34	254 33 02	(A) Riverton	1,787.3
					359 56 00	179 56 00	⊡ 18/2	757.7
					236 26 35		Donaldson Chy	
					344 28 05		Cofield Chy	
⊡ 18/7	30 08 28.40	874.5	90 56 17.36	464.7				
⊡ 18/2	30 07 59.83	1,842.4	90 56 14.21	380.4	335 16 24	155 16 32	⊡ 18/8	1,016.8
					53 32 54		Hermitage Chy	
⊡ 18/7	30 07 29.83	918.6	90 55 58.32	1,561.3	180 01 04		Cofield S. H. Chy	
					178 35 54		Cofield Stack	
					72 22 09		Hermitage Chy	
					201 36 35		Clark Chy	
⊡ 18/2	30 06 20.34	626.3	90 53 57.58	1,541.8	77 34 33	257 34 16	⊡ 18/3	940.2
					143 25 26		Union Stack	
⊡ 18/9	30 06 13.77	424.0	90 54 31.87	853.4	274 10 51		St. Mary's Chy	
⊡ 18/8	30 06 08.39	258.4	90 55 01.23	32.9	75 08 03	255 07 47	⊡ 18/0	884.3
⊡ 18/2	30 06 01.02	31.4	90 55 33.15	887.6	169 51 56	349 51 53	(A) Lemann	925.6
					344 03 00		Salsburg Chy	
⊡ 18/1	30 04 38.40	1,182.5	90 53 06.40	171.4	26 19 07	206 19 00	⊡ 18/1	835.6
					108 12 49		M. E. Church	
					333 37 37		Vegas S. H	
⊡ 18/1	30 04 14.07	433.3	90 53 20.23	541.8				
⊡ 18/1	30 03 45.42	1,398.6	90 53 36.42	975.5	16 35 07	196 35 02	⊡ 18/1	990.9
⊡ 18/1	30 03 14.58	449.0	90 53 46.98	1,258.6	147 14 14		Salsburg Chy	
					230 22 57		Zion church	
⊡ 18/2	30 03 14.98	461.3	90 49 52.41	1,404.0	67 40 23	247 40 09	⊡ 18/3	791.4
					33 16 40	213 16 33	(A) Donnelson	
					355 10 33		St. Michael's Church	
⊡ 18/2	30 03 05.22	160.7	90 50 19.74	528.8	303 36 52	123 36 59	(A) Donnelson	446.7
⊡ 18/2	30 02 52.16	1,606.2	90 50 47.11	1,262.1	61 04 31	241 04 17	⊡ 18/2	856.1
⊡ 18/2	30 02 38.70	1,191.7	90 51 15.08	404.0	99 42 57	279 42 30	(A) Webre	1,489.8
					333 30 17		St. James's Church	
⊡ 18/3	30 00 57.44	1,768.8	90 49 10.33	276.8	72 56 54	252 56 38	⊡ 18/3	882.8
					51 55 07	231 54 54	St. Michael's Church	
⊡ 18/3	30 00 49.08	1,509.8	90 49 41.82	1,120.7	347 38 06		do	
⊡ 18/3	30 00 43.13	1,328.1	90 50 16.56	443.8	67 39 49	247 39 36	⊡ 18/3	762.9
					276 44 32		St. Michael's Church	
					171 03 15		St. James's Church	
					115 46 20		La Pice S. H	

During the entire season the weather was, in the main, favorable, and no trouble was experienced from high water, except during the last two weeks of the season.

Tertiary triangulation.—At nearly all points enough of the Coast Survey triangulation stations remained to furnish good connections for the system of tertiary triangulation, which was carried along to locate the various bench marks of the survey. Of the 120 Coast Survey stations looked for 68 were found, and these were pretty fairly distributed, except on the stretch of river below Fort Jackson, where it became necessary to make a run of 18 miles between consecutive points of connection.

On this long stretch, however, the shores were flat and on one side mostly open, so that I was enabled to "chain" about half the distance with a steel tape, and the rest of the distance was favorable for triangulation, so that it is believed that the locations of the intermediate points are entirely reliable. During the entire season a good deal of difficulty was experienced in procuring reliable azimuths at the several Coast Survey stations on account of trees, buildings, and levees, which cut off the lines of sight between the consecutive points. For this reason it became necessary often to carry azimuth for long distances, but generally the coördinates could be checked at points sufficiently close to insure good results.

The atmospheric conditions were often unfavorable for observing angles, and it often became necessary to locate tertiary flags in unfavorable positions, such as on mud bars, tops of logs, stumps, docks, or buildings, and for these reasons the triangles did not always close with as much accuracy as could have been desired, but as the country was flat it was practicable to measure frequent tertiary bases, and it was considered more economical and productive of better results to devote less time to the determination of angles and give more attention to the measurement of tertiary bases than is usual in work of this kind.

The 50-meter steel tape, with which the party was provided, proved very serviceable for this work and was brought into almost daily use during the whole progress of the work. Besides the regular tertiary bases so measured there were check distances chained with a 20-meter chain, using ordinary chaining pins, but in the soft, wet ground of the region these determinations did not prove very satisfactory and in almost all instances were used for checks only. In a table which, is appended hereto, giving results of checks on tertiary triangulation, distances of this character are explained in a footnote as being used for checks only, as such determinations were used to detect mistakes in computations or other parts of the work, but did not enter the computations and thereby affect the general results of the work. As an illustration of the inexactness of ordinary chaining I have appended a small table showing the results of measurements of the same lines by tape and by chain. These measurements by tape and by chain were made by different parties, but on the same day. The measurements by tape were made with much care, a spring balance was used to insure uniform tension, and the extremities of each tape length were marked by a tack driven in the top of a stake set for the purpose. The marking of the chain lengths was by ordinary chaining pins, and no more than ordinary care was taken in the work, as the determinations were intended only for check on the work of the tape. The ground on nearly all of these lines was soft, but did not differ materially in that respect from most of the ground on which the chain was used during the general progress of the work. It is, therefore, probable that many of the discrepancies shown between measurements by chain and by computed distances, which were based generally on tape measurements, were due to inaccuracies of chaining rather than to defects in the tertiary triangulation.

As the ultimate object of the tertiary work was to determine the correct geographical positions of the various bench marks, perhaps a better test of the accuracy of the work is shown by the appended table, giving the discrepancies between the tertiary and secondary coördinates in the several runs from one secondary station to another.

Besides the permanent bench marks, a number of conspicuous objects have been located, and nearly all the intermediate tertiary points have been marked by stakes and their positions described, so that many of them will be available for connection for one or two years.

There were, all together, 502 tertiary triangles used during the season's work.

Bench marks.—In view of the lack of permanence that has attended many of the bench marks of former years, I have endeavored to keep steadily and prominently in view the importance of selecting permanent positions for the marks which we have established. For this purpose they have as often as practicable been placed by the sides of roadways and land lines and as much as possible out of way of cultivation and probable improvements. Where they have been put on plantations or other private grounds they have in most cases been so placed with the knowledge and consent of the owners or occupants and with the understanding that they were placed there as permanent and valuable marks of public surveys. They have also been placed with a view to being used as points of location as well as of elevation, and with this object in view they have been located, as has been stated, by triangu-

lation, and, besides, have been occupied and pointings have been taken to various permanent and conspicuous objects in sight. Observations so taken will not only furnish effective means of recovering the points hereafter, but will supply azimuth lines for use in future surveys.

Full descriptions and sketches have been made, and it is believed that in most cases these points may be recovered many years hence, even if the surface marks shall have been removed.

On the extreme lower river some difficulty was experienced in planting the bench marks, owing to the close proximity of the water to the surface of the ground, and it often became necessary to bail water continuously from the holes while the work was being done. In these cases the tiles were well rammed down, and it is believed that they are as stable as any objects in those localities. Two bench marks placed in wet ground at Fort Jackson on the way down seemed not to have settled perceptibly in the two weeks that elapsed before our return to that place.

It is a question, however, in my mind whether any object in the vicinity of the Passes remains permanently at the same elevation—a question that will perhaps not be definitely settled until precise levels shall have been carried down again from above, after a lapse of years.

A table is given below showing number and kind of bench marks established.

Precise levels.—Two precise-level bench marks were established at the head of the Passes and connection was made with the U. S. Engineers' bench mark and two gauges. From that place precise levels were carried on the right bank to Fort Jackson and thence on the left bank to New Orleans, where they were connected with the P. B. M's of 1883, back of the city, and carried to the Coast Survey astronomical post in Lafayette Square. Much less difficulty was experienced on the wet ground of the extreme lower river than was anticipated, a line having been cleared out through the timber, where the roots of trees served as turning points and the uniform atmospheric conditions seemed to largely compensate for the difficulty of leveling over the soft ground.

Assistant Engineer Paige, who was placed in general charge of precise levels, will make a report on the results and methods of that work.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.

Table showing number and character of permanent bench marks established between Donaldsonville, La., and the Head of the Passes, during the progress of the survey of the winter of 1892 and 1893.

	Number.
Ordinary bench marks of tile and pipe	198
Secondary triangulation stations used as ordinary bench marks	6
Other marks used as ordinary bench marks	4
Total ordinary bench marks	208
Precise bench marks of tile and pipe	32
Copper bolt precise bench marks	9
Ordinary bench marks used as precise bench marks	28
Other marks used as precise bench marks	7
Total precise bench marks	76
Total bench marks of all classes	256

Table showing discrepancies in tertiary triangulation.

Stations.	Distance chained or computed.	Distance computed.	Discrepancies.	No. of triangles.	Proportionate discrepancies.
	Meters.	*Meters.*	*Meters.*		
1 92 to 1 82	*791.55	791.43	.12	4	1 in 6,597
1 82 to 1 83	*882.80	883.30	.50	7	1 in 1,766
1 83 to St. James ch	762.88	763.07	.19	3	1 in 4,016
△ 25 to △ 24	952.84	953.07	.23	4	1 in 4,144
1 88 to 1 98	*857.48	857.50	.02	5	1 in 47,874
△ 34 to △ 36	1175.75	1175.76	.01	5	1 in 117,575
△ 39 to ware ho. cupola	752.21	752.16	.05	5	1 in 15,045
△ 44 to △ 46	671.68	671.48	.20	2	1 in 3,358
1 98 to 1 88	*852.20	852.05	.15	2	1 in 5,681
△ 44 to △ 46	671.68	671.70	.02	2	1 in 33,584
1 78 to △ 50	*870.74	870.67	.07	2	1 in 12,439
△ 50 to △ 48	600.32	630.87	.55	3	1 in 1,092
△ 51 to 1 88	*1128.33	1128.17	.16	6	1 in 7,052
ⓐ St. John to St. Johns ch	1692.80	1692.30	.50	7	1 in 3,360
△ 62 to △ 60	950.47	950.38	.09	15	1 in 10,561
2 92 to △ 67	*609.70	609.66	.04	4	1 in 15,242
2 93 to △ 74	*1108.80	1108.36	.56	6	1 in 1,981
2 93 to △ 73	*636.20	636.63	.43	7	1 in 1,481
2 94 to △ 81	*861.70	862.16	.46	17	1 in 1,895
2 94 to △ 78	*875.84	876.24	.40	17	1 in 2,189
2 95 to △ 82	*1024.40	1024.53	.13	2	1 in 7,881
2 99 to 2 98	*784.39	784.42	.12	2	1 in 6,536
△ 86 to 2 99	*713.37	713.86	.39	3	1 in 1,830
2 97 to △ 95	*1005.30	1006.40	.90	4	1 in 1,117
2 97 to △ 94	*895.14	895.26	.12	3	1 in 7,459
△ 88 to △ 90	1123.36	1123.35	.01	3	1 in 112,336
ⓐ Odier to Duseau S. H. Chy	648.10	648.20	.10	7	1 in 6,481
△ 102 to △ 105	1212.64	1212.54	.10	4	1 in 12,126
△ 104 to △ 106	*620.89	620.61	.28	2	1 in 2,218
△ 117 to 2 11	*822.40	822.14	.26	5	1 in 3,163
ⓐ City Park to △ 119	481.39	481.19	.20	5	1 in 2,407
2 12 to ⓐ Com. canal	582.27	582.25	.02	4	1 in 29,113
△ Donovan No. 2 to Cubits Chy	2009.64	2009.67	.03	2	1 in 66,988
2 14 to 2 15	1173.43	1173.53	.10	10	1 in 11,735
2 13 to △ 127	800.00	800.05	.05	8	1 in 16,000
△ 131 to △ 129	1450.00	1449.04	.96	2	1 in 1,510
△ 136 to 2 11	806.97	806.82	.15	7	1 in 5,380
△ 143 to △ 140	955.84	956.06	.22	2	1 in 4,345
△ 152 to 2 18	1056.65	1056.47	.18	9	1 in 5,780
△ 170 to △ 173	686.48	686.32	.16	11	1 in 4,280
△ 189 to △ 190	721.28	721.48	.20	27	1 in 3,606
△ 197 to ⓐ Union	632.65	632.57	.08	2	1 in 7,903
△ 211 to △ 212	929.61	929.39	.22	14	1 in 4,226
△ 217 to △ 219	548.95	549.07	.12	4	1 in 4,574
2 18 to Junior Chy	834.84	834.78	.06	9	1 in 13,914
△ 231 to △ 233	1256.10	*1254.62	1.48	4	1 in 848
2 15 to △ 247	712.93	713.19	.26	12	1 in 3,128
△ 236 to 2 16	*529.12	529.30	.18	4	1 in 2,941
△ 250 to △ 252	1067.09	1067.08	.01	11	1 in 106,709
△ 256 to ... Bayhi	630.70	630.66	.04	6	1 in 15,737
△ 258 to 2 13	727.97	728.03	.06	4	1 in 12,133
△ 264 to 2 23	789.73	789.66	.07	8	1 in 11,267
△ 268 to △ 267	823.21	823.26	.03	5	1 in 16,465
2 12 to 2 22	*560.40	560.35	.05	6	1 in 11,208
△ 276 to 2 21	919.70	919.50	.20	4	1 in 4,598
△ 271 to △ 272	730.09	729.98	.11	10	1 in 6,637
△ 275 to △ 276	868.73	868.81	.08	5	1 in 10,860
△ 278 to △ 280	1057.10	1057.24	.14	5	1 in 7,551
2 21 to 2 31	747.62	747.69	.03	2	1 in 24,920
△ 281 to △ 282	739.70	739.91	.21	13	1 in 3,523
△ 288 to 2 20	*536.43	536.43	.00	4	1 in ∞
2 29 to △ 288	833.99	833.95	.04	5	1 in 20,850
△ 292 to △ 287	786.31	786.13	.18	11	1 in 4,368
ⓐ Magnolia to 2 28	1,083.09	1,083.09	.00	2	1 in ∞
△ 295 to 2 18	*1,040.21	1,039.72	.49	4	1 in 2,123
△ 308 to 2 16	985.49	985.44	.05	4	1 in 19,710
ⓐ Battle Ground, Refinery Chy	1,621.63	1,621.74	.11	2	1 in 14,742
△ 308 to Refinery Chy	986.01	986.00	.01	6	1 in 98,601
△ 307 to 2 16	1,214.73	1,214.61	.12	4	1 in 10,126
2 18 to Colored Church	540.64	540.60	.04	2	1 in 13,516

* Used for check only.

Table showing discrepancies between tape and chain measurements.

Stations.	Measured with tape.	Measured with chain.	Discrepancy.	Character of ground.	Proportionate discrepancies.
	Meters.	*Meters.*	*Meters.*		
1½ to △ 127	800.06	799.84	—.22	Soft.....	1 in 3,637
△ 129 to △ 131	1,450.05	1,449.36	—.69	....do ...	1 in 2,101
△ 131 to 2½	1,640.11	1,640.21	+.10	Hard ...	1 in 16,402
1½ to △ 133	980.12	980.00	—.12	Soft.....	1 in 8,168
2½ to △ 139	1,062.07	1,061.50	—.57	....do ...	1 in 1,863
△ 139 to △ 141	1,500.12	1,499.20	—.92	....do ...	1 in 1,631
△ 141 to △ 143	1,370.12	1,369.30	—.82	....do ...	1 in 1,671
△ 143 to 2½	1,472.54	1,471.80	—.74	....do ...	1 in 1,981
2½ to △ 245	1,100.00	1,099.55	—.45	....do ...	1 in 2,444

Discrepancies between tertiary and secondary coördinates, Donaldsonville, La., to Head of Passes.

From station.	To station.	Number of triangles.	Distance.	Discrepancy in latitude.	Discrepancy in longitude.	Proportional discrepancy.
			Miles.	*Meters.*	*Meters.*	
Webre	Donalson	6	2.2	0.8	0.2	1: 4,317
St. James	St. Michael's Church.	4	1.8	0.7	0.6	1: 3,133
St. Emma	College	7	4.7	1.0	0.0	1: 7,520
Jolly	Homestead	8	4.2	1.6	0.6	1: 4,188
Do	Jolly	5	5.1	0.9	1.3	1: 5,100
White Rose	Chauf	10	2.4	1.5	0.3	1: 2,560
St. John	Reserve	7	3.9	1.1	0.4	1: 5,200
Reserve	Round-house	12	5.6	0.2	0.6	1:14,860
Kilana	Becuar	12	4.5	0.8	0.1	1: 9,000
Bois Blanc	Avondale	3	2.1	1.0	0.1	1: 3,360
Company Canal	City Park	7	1.4	1.1	0.8	1: 1,640
Lee	St. Maurice	5	2.5	0.3	0.2	1:11,110
Orleans	Battle ground	5	1.9	0.0	0.2	1:15,200
Magnolia	Orange Grove	2	1.6	0.4	0.5	1: 4,000
Scarsdale	do	18	4.9	0.7	1.6	1: 4,360
Concessions	Scarsdale	6	2.3	0.3	1.1	1: 3,345
Do	Cedar	11	3.9	0.5	0.5	1: 8,910
Berthaud	Jesuit	8	1.4	0.6	0.3	1: 3,700
Jesuit	Bayhi	8	2.4	0.1	0.2	1:19,200
Bayhi	St. Rosalie	15	4.8	0.4	0.5	1:12,000
St. Rosalie	Woodland	22	9.5	3.9	1.3	1: 3,700
Upper Base	Union	18	5.6	0.6	0.1	1:14,930
Union	White	18	7.5	1.1	1.6	1: 6,320
White	Grand Prairie	21	8.3	0.5	0.5	1:19,000
Quarantine	Buras Church	2	0.7	0.8	0.1	1: 1,400
North	Taylor	42	18.6	1.8	1.4	1:12,940
H. P. Light	North	3	4.2	0.3	0.5	1:12,200

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana.

[Latitudes and longitudes are derived from C. and G. S. triangulation △'s.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ [illegible]	30	07	14.84	457.0	90	57	35.62	953.5	14	55	52	194	55	48	⊡ [illegible]	925.4
⊡ [illegible]	30	06	45.81	1,410.7	90	57	44.52	1,191.8	14	34	51	194	34	46	△ North Base	
									80	17	51				Hermitage S. H	
⊡ [illegible]	30	08	53.01	1,632.4	90	56	17.39	465.4	74	33	34	254	33	02	△ Riverton	1,787.3
									359	56	00	179	56	00	⊡ [illegible]	757.7
									236	26	35				Donaldson Chy	
									344	28	05				Cofield Chy	
⊡ [illegible]	30	08	28.40	874.5	90	56	17.36	464.7								
⊡ [illegible]	30	07	59.83	1,842.4	90	56	14.21	380.4	335	16	24	155	16	32	⊡ [illegible]	1,016.8
									53	32	54				Hermitage Chy	
⊡ [illegible]	30	07	29.83	918.6	90	55	58.32	1,561.3	180	01	04				Cofield S. H. Chy	
									178	35	54				Cofield Stack	
									72	22	09				Hermitage Chy	
									201	36	35				Clark Chy	
⊡ [illegible]	30	06	20.34	626.3	90	53	57.58	1,541.8	77	34	33	257	34	16	⊡ [illegible]	940.2
									143	25	26				Union Stack	
⊡ [illegible]	30	06	13.77	424.0	90	54	31.87	853.4	274	10	51				St. Mary's Chy	
⊡ [illegible]	30	06	08.39	258.4	90	55	01.23	32.9	75	08	03	255	07	47	⊡ [illegible]	884.3
⊡ [illegible]	30	06	01.02	31.4	90	55	33.15	887.6	169	51	56	349	51	53	△ Lemann	925.6
									344	03	00				Salsburg Chy	
⊡ [illegible]	30	04	38.40	1,182.5	90	53	06.40	171.4	26	19	07	206	19	00	⊡ [illegible]	835.6
									108	12	49				M. E. Church	
									333	37	37				Vegas S. H	
⊡ [illegible]	30	04	14.07	433.3	90	53	20.23	541.8								
⊡ [illegible]	30	03	45.42	1,398.6	90	53	36.42	975.5	16	35	07	196	35	02	⊡ [illegible]	990.9
⊡ [illegible]	30	03	14.58	449.0	90	53	46.98	1,258.6	147	14	14				Salsburg Chy	
									230	22	57				Zion church	
⊡ [illegible]	30	03	14.98	461.3	90	49	52.41	1,404.0	67	40	23	247	40	09	⊡ [illegible]	791.4
									33	16	40	213	16	33	△ Donnelson	
									355	10	33				St. Michael's Church	
⊡ [illegible]	30	03	05.22	160.7	90	50	19.74	528.8	303	36	52	123	36	59	△ Donnelson	446.7
⊡ [illegible]	30	02	52.16	1,606.2	90	50	47.11	1,262.1	61	04	31	241	04	17	⊡ [illegible]	850.1
⊡ [illegible]	30	02	38.70	1,191.7	90	51	15.08	404.0	99	42	57	279	42	30	△ Webre	1,489.8
									333	30	17				St. James's Church	
⊡ [illegible]	30	00	57.44	1,768.8	90	49	10.33	276.8	72	56	54	252	56	38	⊡ [illegible]	882.8
									51	55	07	231	54	54	St. Michael's Church	
⊡ [illegible]	30	00	49.03	1,509.8	90	49	41.82	1,120.7	347	38	06				do	
⊡ [illegible]	30	00	43.13	1,328.1	90	50	16.56	443.8	07	39	49	247	39	36	⊡ [illegible]	762.9
									276	44	32				St. Michael's Church	
									171	03	15				St. James's Church	
									115	46	20				La Pice S. H	

⊡ 122	30	00	33.71	1,038.1	90	50	42.80	1,149.3	106	20	36	286	20	14	⛪ St. James	1,230.0
									214	14	19				St. James's Church	
									140	17	25				La Pice S. H. Chy	
									74	59	45				Forstall S. H.	
⊡ 123 = ⛪ College	30	00	07.25	223.3	90	49	02.55	68.4	823	04	38	143	04	46	⊡ 124	744.3
⊡ 124	29	59	47.03	1,425.9	90	48	45.87	1,229.4								
⊡ 125	29	59	12.44	383.1	90	48	18.95	508.0	335	38	13	155	38	19	⊡ 126	775.6
									356	14	23				Pikes Peak Chy	
⊡ 126	29	58	49.50	1,524.3	90	48	07.02	188.2	132	41	03				College Chy	
									15	21	23				Pikes Peak Chy	
⊡ 127	30	01	37.60	1,157.8	90	46	07.46	199.9	257	24	33	77	25	28	⛪ Jolly	8,030.1
									356	08	59	176	09	00	⊡ 128	975.3
									335	21	36				Belle Alliance	
⊡ 128	30	01	06.00	184.8	90	46	05.01	134.8	248	32	55	68	33	01	do	346.7
									136	15	40				Belmont Chy	
⊡ 129	30	00	27.69	852.7	90	46	01.98	53.1	351	01	20	171	01	22	⊡ 130	537.6
									190	27	51				Belle Alliance	
									347	55	00				Felicite Chy	
									47	15	32				Oak Alley Chy	
⊡ 131	30	00	10.45	321.8	90	45	58.85	1,577.3	184	54	07				Belle Alliance	
									80	24	49				Oak Alley Chy	
⊡ 132	30	01	34.57	1,064.5	90	43	34.87	934.3	123	59	02	303	58	41	⛪ Jolly	1,354.5
									260	14	59	80	15	26	△ Chapel	1,446.7
									337	04	22	157	04	27	⊡ 133	722.4
									78	31	27				Belle Alliance	
									336	37	29				Catholic Church	
⊡ 133	30	01	12.97	399.4	90	43	24.37	653.0	170	00	29				Borgeois S. H.	
									336	14	34				Catholic Church	
⊡ 134	30	00	45.44	1,399.2	90	43	11.04	295.9	338	47	47	158	47	53	⊡ 135	857.5
									276	20	39				Iron Smokestack	
⊡ 135	30	00	19.48	599.9	90	42	59.47	1,593.9	12	07	52				Wagenspeck Chy	
									70	44	20				Dupare Bagasse Burner	
⊡ 136	30	03	14.62	450.2	90	41	01.57	42.1	323	58	03	143	58	12	⊡ 137	817.0
									62	42	43				Ross S. H. Chy	
									32	24	38				Sawmill Stack	
⊡ 137	30	02	53.16	1,637.0	90	40	43.63	1,168.8	98	52	32				Ross S. H. Chy	
⊡ 138	30	02	30.43	937.1	90	40	24.94	668.0	350	08	01	170	08	03	⊡ 139	675.7
									116	10	21				Ross S. H. Chy	
									83	49	27				Sawmill Stack	
⊡ 139	30	02	08.81	271.3	90	40	20.62	552.4	253	45	10				S. H. Chy. R. B.	
									299	18	10				Tall Brick Chy	
⊡ 140	30	02	42.40	1,305.6	90	37	29.89	800.6	55	26	17	235	26	03	⊡ 141	884.7
									262	38	17				Hope S. H. Chy	
⊡ 142	30	02	26.10	803.7	90	37	57.08	1,529.4	247	18	33				do	
									223	56	03				Chauff Chy	
⊡ 143	30	02	01.06	32.6	90	38	37.83	1,013.6	63	55	13	243	54	59	⊡ 144	852.1
⊡ 144	30	01	48.89	1,505.5	90	39	06.39	171.2								
⊡ 145	30	03	36.35	1,119.3	90	36	09.08	243.2	342	33	01	162	33	07	⊡ 146	1,109.7
									64	18	38	244	18	21	⛪ Chauff	1,023.7
									268	17	03				Reserve S. H. Chy	
⊡ 147	30	03	01 95	60.1	90	35	56.65	1,517.5								
⊡ 148	30	02	38.22	1,176.9	90	35	42.47	1,137.8	337	43	40	157	43	46	⊡ 149	855.1

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation ⓐ's.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	*Meters.*	° ′ ″	*Meters.*	° ′ ″	° ′ ″		*Meters.*
⊡ $\frac{192}{4}$	30 02 12.50	384.9	90 35 30.37	813.7	61 39 50	241 39 26	Ⓐ White Rose	1,453.5
					85 38 19		Snyder S. H	
					63 19 05		Carroll S. H	
⊡ $\frac{210}{1}$	30 03 31.11	958.0	90 32 54.30	1,454.4	2 41 36	182 41 35	⊡ $\frac{210}{2}$	663.8
					72 05 46		St. Peter's Church	1,224.4
					34 31 48		St. John's Church	
⊡ $\frac{210}{2}$	30 03 09.57	294.7	90 32 55.47	1,485.9				
⊡ $\frac{210}{3}$	30 02 43.17	1 329.4	90 32 55.64	1,490.5	2 30 31	182 30 30	⊡ $\frac{202}{4}$	1,025.2
					10 48 59		McBecknel Chy	
					28 08 19		Carle S. H	
⊡ $\frac{200}{4}$	30 02 09.89	304.6	90 32 57.31	1,535.6	62 30 05	242 29 46	Ⓐ St. John	1,142.0
					143 52 48		St. John's Church	1,431.8
					35 11 22		Webre S. H	
					50 56 58		Carle S. H	
⊡ $\frac{201}{1}$	30 04 08.41	259.0	90 30 08.86	237.3	352 15 46	172 15 48	⊡ $\frac{201}{2}$	823.1
⊡ $\frac{201}{3}$	30 03 41.92	1,290.9	90 30 04.73	126.7	175 03 36		Bagasse Burner	
					226 42 00		R. R. Water Tank	
⊡ $\frac{201}{4}$	30 03 00.85	26.2	90 30 07.71	206.5	13 34 08	193 34 05	⊡ $\frac{202}{1}$	761.6
⊡ $\frac{202}{1}$	30 02 36.80	1,133.2	90 30 14.38	385.3				
⊡ $\frac{202}{2}$	30 00 50.30	1,548.9	90 28 17.00	455.6	126 47 47	306 47 38	⊡ $\frac{202}{2}$	588.1
⊡ $\frac{202}{3}$	30 01 01.74	53.6	90 28 34.57	926.4				
⊡ $\frac{202}{3}$	30 01 37.75	1,162.5	90 29 20.39	546.2	131 19 15	311 19 06	⊡ $\frac{202}{3}$	610.4
					143 59 05		Lindall S. H	
					164 14 10		Chimney	
⊡ $\frac{202}{4}$	30 01 50.84	1,565.6	90 29 37.50	1,004.8	71 04 16	251 03 31	Ⓐ Kennemore	2,538.7
					110 55 38		Gold Mine Chy	3,096.6
⊡ $\frac{203}{1}$	30 00 27.02	832.0	90 27 08.07	216.3	11 04 54	191 04 52	⊡ $\frac{202}{3}$	621.7
					292 01 31		Kilona S. H	
					59 29 24		Ross S. H	
⊡ $\frac{203}{2}$	30 00 07.21	222.0	90 27 12.53	335.8	282 28 35		Providence Church	
⊡ $\frac{203}{2}$	29 59 33.93	1,044.8	90 27 19.14	513.0	18 19 18	198 19 13	⊡ $\frac{203}{3}$	840.1
					209 55 03		Providence Church	
⊡ $\frac{203}{3}$	29 59 08.03	247.3	90 27 28.99	777.1	204 51 36		do	
⊡ $\frac{204}{4}$	29 59 45.76	1,409.1	90 23 42.62	1,142.3	49 02 23	229 02 11	⊡ $\frac{204}{4}$	840.5
					32 38 08		Hahnville Church	
					342 03 15		Sarpy's S. H. Cupola	
⊡ $\frac{204}{3}$	29 59 27.85	857.5	90 24 06.31	169.2	277 52 21		Sarpy's S. H. Cupola	
					313 19 48		Lightning rod	
⊡ $\frac{204}{1}$	29 59 12.53	385.8	90 24 32.18	862.6	52 52 43	232 52 32	⊡ $\frac{204}{4}$	750.6
⊡ $\frac{204}{2}$	29 58 57.82	1,780.2	90 24 54.50	1,460.9	316 19 45		Hahnville Church	
					116 02 21		Star Church	

⊡ 28½	29	57	47.46	1,461.2	90	22	51.72	1,386.7	33	27	41	213	27	30	⊡ 28½ 1,074.3
									338	18	19	158	18	29	Red Church
									158	52	28				Sarpy's S. H. Cupola
									357	04	31				Ashley's S. H. Chy
⊡ 28¾	29	57	18.35	565.1	90	23	13.81	370.4							
⊡ 29	29	56	49.62	1,527.8	90	23	32.46	870.5	38	23	17	218	23	07	⊡ 29 826.0
									7	07	15				⊗ La Fitte
									201	48	55				Ormond S. H. Chy
⊡ 29¼	29	56	28.59	880.3	90	23	51.59	1,383.6	332	57	42	152	57	48	⊗ La Fitte 764.0
									207	27	54				Ormond S. H. Chy
									307	29	14				Ashley's S. H. Chy
⊡ 29½	29	56	44.19	1,360.6	90	20	26.65	714.6	0	21	02	180	21	02	⊡ 29½ 784.4
									49	42	06				Alicia S. H. Chy
									63	16	59				Ashley S. H. Chy
⊡ 29¾	29	56	18.71	576.1	90	20	26.83	719.6	267	34	27				S. H. Chimney
									239	27	22				S. H. down river
⊡ 30	29	55	49.13	1,512.7	90	20	34.53	926.1	17	09	15	197	09	10	⊡ 30 856.3
									91	15	46				Alicia Chy
									87	16	04				Ashley Chy
⊡ 30¼	29	55	22.56	694.6	90	20	43.94	1,178.7	119	53	20				Alicia Chy
									101	23	13				Ashley Chy
⊡ 30½	29	58	02.91	89.6	90	18	35.40	949.1	316	29	34	136	29	46	⊡ 30½ 944.7
									267	46	04				Price S. H. Chy
									252	56	37				Frelson S. H. Chy
⊡ 30¾	29	57	40.66	1,251.9	90	18	11.14	298.7	63	51	11				Ashley Chy
									164	27	43				Price Chy
									224	43	30				Frelson Chy
⊡ 31	29	57	13.64	420.0	90	17	46.59	1,249.3	324	12	59	144	13	07	⊡ 31 763.3
⊡ 31¼	29	56	53.53	1,648.1	90	17	29.94	802.8	183	14	40				Frelson Chy
									48	46	12				Louise Chy
⊡ 31½	29	58	57.52	1,771.0	90	15	01.63	43.7	8	54	22	188	54	19	⊡ 31½ 1,022.1
									298	23	07				Methodist Church
									23	28	45				Oakland Church
									37	07	48				Johnson S. H.
⊡ 31¾	29	58	24.72	761.1	90	15	07.53	201.9	232	34	49				Catholic Church
⊡ 32	29	57	58.95	1,815.2	90	15	11.43	306.4	10	43	49	190	43	47	⊡ 32 716.8
									343	38	39				Duscau Chy
⊡ 32¼	29	57	36.08	1,110.9	90	15	16.41	440.0	293	52	07	113	52	18	⊗ Odier 673.8
									224	04	55				Duscau Chy
⊡ 32½ Bois Blanc	29	56	46.35	1,427.1	90	12	33.77	905.5	45	36	37	225	36	23	⊡ 32½ 1,047.9
									355	26	17	175	26	21	Jefferson Church 2,797.9
									358	12	34				Soniat S. H
⊡ 32¾	29	56	22.54	694.1	90	13	01.69	45.3	317	24	33				Soniat S. H
									252	00	23				Frenia S. H
⊡ 33	29	56	07.72	247.7	90	13	30.34	813.7	55	29	11	235	28	58	⊡ 33 858.5
									23	10	36				Smith Pump House
									9	29	14				Smith S. H.
									50	46	59				Section House Chy
⊡ 33¼	29	55	51.92	1,598.6	90	13	56.71	1,521.0	268	07	33				Sugar House Chy
									234	27	21				Chy. on house

Stone line B. Ms., geographical positions, Donaldsonville to head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation ⓢ's.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ 2½⁰	29	56	32.02	985.9	90	11	46.63	1,250.4	315	32	55	135	33	06	⊡ 2½⁰	843.4
									217	12	00				Sugar House Chy	
									308	40	40				Gable Ag. Col. Barn	
⊡ 2½⁹	29	56	12.47	383.9	90	11	24.61	660.0								
⊡ 2½⁹	29	55	44.45	1,368.6	90	10	54.49	1,461.4	316	30	14	136	30	22	⊡ 2½⁹	605.4
									228	07	17				La Branch Chy	
									39	25	57				Avondale Chy	
⊡ 2½⁸	29	55	30.19	929.5	90	10	38.96	1,044.9	72	41	54	252	41	22	Ⓐ Avondale	1,812.5
									203	22	13				La Branch Chy	
									60	17	51				Avondale Chy	
⊡ 2½¹	29	57	52.18	1,606.6	90	08	18.44	494.4	22	51	05	202	50	59	⊡ 2½¹	771.7
									342	20	18				Electric-Light Tower	
									37	13	28				Water Tank	
									75	43	35				Church Spire	
⊡ 2½¹	29	57	29.08	895.3	90	08	29.62	794.3								
⊡ 2½¹	29	57	03.88	119.5	90	08	52.75	1,414.5	33	12	39	213	12	32	⊡ 2½¹	703.6
									285	25	12				Catholic Church	
									210	25	54				Edge of Elevator	
									145	49	02				Church Spire	
									55	37	08	235	36	26	La Branch Chy	2,757.6
⊡ 2½¹	29	56	44.76	1,378.1	90	09	07.12	190.9	211	37	45				Edge of Elevator	
									260	41	21				Church Spire	
⊡ 2½² ⓟ City park	29	55	36.43	1,121.5	90	07	48.94	1,312.5	28	45	09	208	45	05	⊡ 2½²	459.7
									262	55	19				St. Charles Str. Church	
									262	00	29				Asylum	
									231	27	09				Standpipe	
⊡ 2½²	29	55	23.35	718.9	90	07	57.18	1,533.8	221	47	28				Standpipe	
									198	20	40				Church Spire	
									87	34	05				Elevator Stack	
⊡ 2½²	29	54	51.92	1,598.6	90	08	22.56	605.2	31	42	58	211	42	51	⊡ 2½²	747.6
									70	50	11	250	50	01	Ⓐ Company Canal	582.3
									155	53	20				Elevator Tank	
									155	26	48				Elevator Stack	
									72	30	43				R. R. Tank	
⊡ 2½²	29	54	31.27	962.8	90	08	37.21	998.1	160	33	27	340	33	24	Ⓐ Company Canal	471.7
									271	41	53				Brickyard Chy	
									164	07	05				Zerringer Chy	
									238	09	48				Square Tower	
⊡ 2½³	29	55	36.77	1,132.1	90	05	22.40	627.6								
⊡ 2½³	29	55	25.12	773.4	90	05	23.48	629.8	242	24	39				M. E. Church	

⊡ 2½³	29	54	22.58	695.2	90	04	55.51	1,480.3	312	55	56	162	56	00	⊡ 2½³	787.1
									284	45	26	104	45	54	◇ Gretna	1,502.5
									85	08	42				Ames S. H	
⊡ 2½³	29	53	58.14	1,790.1	90	04	46.90	1,258.3	254	31	30	74	31	44	ⓐ Gretna	1,428.1
									203	43	48				Brick Chy. N. O	
									148	30	48				Carrolton Av. Church	
									168	11	36				Louisiana Av. Church	
⊡ 2½⁴ = Astronomical Post	29	56	57.86	1,781.3	90	04	11.46	307.3								
⊡ 2½⁴	29	56	47.40	1,459.4	90	03	46.49	1,246.6	319	13	42	139	14	00	Tank	1,457.1
									108	48	05				1st Pres. Church	
⊡ 2½⁴	29	56	35.98	1,107.8	90	02	53.41	1,432.3	295	48	20	115	48	34	ⓐ Algiers	826.3
									32	07	27	212	07	15	Tank	887.9
									105	33	08				1st Pres. Church	
									167	28	59				St. Mary's Church	
⊡ 2½⁴ = ⓐ Algiers	29	56	24.30	748.1	90	02	25.67	688.3	108	19	52	288	18	58	1st Pres. Church	3,039.4
									145	16	24				St. Louis Cathedral	
									150	16	37	330	16	07	3d Pres. Church	3,236.0
									207	46	09	27	46	30	Ursuline Convent	2,427.2
									156	05	13	336	04	48	St. Peters and St. Pauls Ch.	3,361.9
									159	56	00	339	55	48	Oil Works Chy	1,833.2
									161	53	53	341	53	34	German M. E. Church	3,259.3
									120	54	50	300	53	56	Christ Church	3,396.3
									159	18	26	339	18	07	White Spire	2,946.4
⊡ 2½⁵	29	57	59.47	1,831.0	90	01	12.09	324.1	17	11	00	197	10	54	⊡ 2½⁵	1,030.2
									825	58	55	145	59	10	ⓐ St. Maurice	1,409.8
									47	06	05				Ursuline Convent	1,149.7
⊡ 2½⁵	29	57	27.51	847.0	90	01	23.44	628.5								
⊡ 2½⁵	29	56	49.63	1,528.0	90	01	29.01	777.9	3	18	49	183	18	48	⊡ 2½⁵	717.3
									315	32	48	135	32	53	Church	381.1
⊡ 2½⁵	29	56	26.38	812.2	90	01	30.56	819.6	315	51	22	135	51	35	◇ Lee	991.9
									266	34	05				◇ Chalmette	
									214	46	42	34	46	48	Church	540.6
									131	42	13				Spire	
⊡ 2½⁵	29	56	37.05	1,140.7	89	58	35.50	952.0	275	11	13	95	11	35	◇ Battleground	1,200.7
									25	47	06	205	46	59	⊡ 2½⁵	969.0
									89	29	34				◇ Chalmette	
									4	53	24	184	53	22	Refinery Chy	1,086.4
⊡ 2½⁵	29	56	10.47	322.4	89	58	50.24	1,347.4	245	57	03	65	57	45	◇ Battleground	1,742.4
									122	08	31				◇ Chalmette	
⊡ 2½⁵	29	55	35.83	1,103.2	89	59	01.95	132.8	6	39	05	186	39	03	◇ 2½⁵	893.9
⊡ 2½⁵	29	55	06.80	209.4	89	59	08.84	237.1	278	24	36	98	24	51	◇ Orleans	823.6
									164	12	15				◇ Chalmette	
									205	24	00	25	24	14	Refinery Chy	
P. B. M. 37	29	55	59.58	1,834.4	89	57	27.94	749.4	149	29	07	329	28	56	◇ Battleground	1,213.3
									91	51	02				Refinery Chy	
P. B. M. 36	29	54	42.26	1,301.1	89	54	23.68	635.2	152	37	50				Story S. H. Chy	
									192	40	45				Pump House Chy	
⊡ 2½⁷ ◇ Du Cross	29	56	10.21	314.5	89	55	25.36	680.1	36	07	11	216	07	01	◇ 2½⁷	937.1
									326	07	49				Story S. H	
⊡ 2½⁷	29	55	45.62	1,404.6	89	55	45.96	1,232.6								
⊡ 2½⁷	29	55	13.24	407.6	89	56	10.63	285.1	39	15	51	219	15	43	◇ 2½⁷	681.1
									267	13	19				Story S. H. Chy	

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation △'s.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ 21¹	29	54	56.11	1,727.6	89	56	26.70	716.2	193	46	30				Stanton S. H. Cupola	
									119	36	00				Jarvin S. H	
⊡ 21²	29	53	46.36	1,427.4	89	53	26.84	720.1	73	41	42	253	41	28	⊡ 21¹²	803.4
									7	44	39				Poydras S. H	
⊡ 21⁴	29	53	39.03	1,201.7	89	53	55.58	1,491.2	165	41	34				Tile Works Chy	
⊡ 21⁵	29	53	22.60	695.8	89	54	33.20	890.9	83	30	01	263	29	47	⊡ 21⁸	705.2
									27	54	28				12 Mile Pt S. H	
									327	53	53				Poydras S. H	
⊡ 21⁷	29	53	19.79	609.3	89	55	01.53	41.1	57	38	45	237	38	28	△ Magnolia	1,083.1
									327	54	27				12 Mile Pt S. H	
									314	38	32				Poydras S. H	
P. B. M. 35	29	52	17.45	537.3	89	53	47.10	1,264.1								
P. B. M. 34	29	52	19.99	615.5	89	56	59.14	1,587.2	295	11	51	115	12	04	Orange Grove S. H	751.5
⊡ 21⁶	29	51	35.97	1,107.5	89	56	00.81	21.7	178	56	55	358	56	55	⊡ 21⁵	707.0
									139	27	49	319	27	33	Orange Grove S. H	1,362.6
									253	51	01				Poydras S. H	
⊡ 21⁹	29	51	58.92	1,814.1	89	56	01.29	34.6	110	38	22				Orange Grove S. H	932.5
⊡ 21³	29	52	33.64	1,035.7	89	55	54.16	1,453.3	210	35	33	30	35	42	△ Magnolia	977.3
									55	10	08				Orange Grove S. H	
									245	56	18				12 Mile Pt S. H	
⊡ 21⁴ △ Magnolia	29	53	00.96	29.5	89	55	35.63	956.0	271	39	42	91	40	06	....do	1,302.5
									296	40	09	116	41	06	Poydras S. H	3,421.1
⊡ 21¹⁰	29	52	03.56	1,096.0	89	57	40.84	109.6	118	33	18	298	33	05	⊡ 21¹⁰	792.3
									34	30	31				Scarsdale S. H	
									86	09	58				St. Clair S. H	
⊡ 21⁰	29	52	15.86	488.3	89	58	06.77	181.7	274	23	50				Orange Grove L. Rod	
									358	34	20				St. Clair S. H	
									42	34	32				Belle Chasse S. H	
⊡ 21⁰	29	52	27.43	844.5	89	58	38.36	1,029.5	116	05	53	296	05	46	⊡ 21¹²	450.7
									16	32	47				Belle Chasse S. H. Chy	
⊡ 21⁰	29	52	33.87	1,042.8	89	58	53.44	1,434.0	4	17	34				Belle Chasse S. H	
									307	46	58				St. Clair S. H	
P. B. M. 33	29	51	02.47	76.0	89	58	27.29	732.5	130	12	54				Belle Chasse	
									37	40	41				Scarsdale S. H	
P. B. M. 32	29	49	22.02	678.0	89	59	44.47	1,194.1	159	50	53				Concession Church	
⊡ 21¹¹	29	49	49.44	1,522.2	89	58	54.53	1,464.0	177	50	33	357	50	33	△ Scarsdale	704.9
									119	30	03	299	29	51	△ 21¹¹	747.6
									177	32	18				Belle Chasse Chy	
									190	29	43				Scarsdale S. H	
⊡ 21¹	29	50	01.39	42.8	89	59	18.77	504.0	241	41	17	61	41	29	△ Scarsdale	708.9
									191	19	46				Belle Chasse Chy	
									215	42	56				Scarsdale S. H	

⊡ 2$\frac{1}{1}$	29	50	19.01	583.3	89	59	51.80	1,390.7	116	09	44	296	09	30	⊡ 2$\frac{1}{1}$	807.2
									214	20	09				Belle Chasse Chy	
									246	34	26				Sugar House	
⊡ 2$\frac{1}{1}$	29	50	31.43	967.5	90	00	20.79	558.1	7	46	39	187	46	36	Ⓐ Concessions	1,144.4
									328	14	38				Concessions Cupola	
									260	53	49				Scarsdale S. H	
⊡ 2$\frac{1}{2}$	29	47	28.49	877.2	89	59	50.64	1,360.3	108	31	52	288	31	38	⊡ 2$\frac{1}{2}$	809.8
									62	57	35	242	57	08	P. B. M. 31	1,641.6
									39	58	33				Greenwood S. H	
									143	12	08				Lindwood Cupola	
⊡ 2$\frac{1}{3}$	29	47	36.85	1,134.6	90	00	19.23	516.5	34	46	50				P. B. M. 31	
									358	44	01				Greenwood S. H	
									204	22	23				Lindwood Cupola	
⊡ 2$\frac{1}{4}$	29	47	56.77	1,747.9	90	00	48.64	1,306.3	84	48	25	264	48	12	Ⓐ Cedar	722.6
									116	30	39	296	30	30	⊡ 2$\frac{2}{2}$	560.4
									202	52	47				Oak Point S. H	
⊡ 2$\frac{2}{1}$	29	48	04.89	150.6	90	01	07.31	196.3	34	39	36	214	39	32	Ⓐ Cedar	383.6
									232	15	17				Oak Point S. H	
P. B. M. 31	29	47	04.25	130.9	90	00	45.07	1,210.6	285	34	49				Greenwood S. H	
									211	33	59				Lindwood Cupola	
P. B. M. 30	29	44	28.84	488.0	89	59	45.93	1,234.4	330	59	08				Belair S. H	
									161	16	16				Fanny S. H	
⊡ 2$\frac{2}{2}$	29	45	36.22	930.4	90	00	34.79	934.6	73	16	46	253	16	38	Ⓑ Berthoud	469.3
									77	42	44				Jesuit Church	
									113	41	54				Live Oak S. H	
⊡ 2$\frac{3}{1}$ = Ⓑ Berthoud	29	45	25.84	795.4	90	00	51.52	1,384.1	80	03	48	260	03	32	Jesuit Church	894.0
									124	36	12	304	35	47	Live Oak S. H	1,610.7
⊡ 2$\frac{3}{3}$	29	45	07.24	222.9	90	01	18.75	503.8	74	16	28	254	16	15	⊡ 2$\frac{3}{1}$	710.7
									160	24	11				Jesuit Church	
⊡ 2$\frac{3}{4}$	29	45	00.98	30.2	90	01	44.21	1,187.9	221	12	36				Jesuit Church	
									183	01	51				Live Oak S. H	
									307	58	22				Union S. H	
P. B. M. 29	29	42	14.69	452.3	89	58	26.77	719.6	175	34	33	355	34	30	⊡ 2$\frac{4}{3}$	
									24	26	39				Sugar House	
⊡ 2$\frac{4}{1}$	29	43	29.65	912.9	89	58	33.41	897.9	63	26	11	243	25	57	⊡ 2$\frac{4}{4}$	855.7
									82	00	58				Belair S. H	
⊡ 2$\frac{4}{2}$	29	43	17.22	530.1	89	59	01.89	50.8	157	57	34				Belair S. H	
⊡ 2$\frac{4}{3}$	29	43	18.42	567.1	89	59	37.80	1,016.0	1	27	58	181	27	57	Ⓒ Bayhi	1,132.5
									70	56	48	250	56	36	⊡ 2$\frac{5}{3}$	680.0
									137	37	24				Star S. H	
⊡ 2$\frac{4}{4}$	29	43	11.22	345.4	90	00	01.72	46.2	326	00	07	146	00	18	Ⓒ Bayhi	1,007.8
									172	03	29				Star S. H	
⊡ 2$\frac{5}{1}$	29	41	21.60	665.0	89	57	17.94	482.4	63	35	50	243	35	38	⊡ 2$\frac{4}{5}$	695.2
									355	41	49				Union S. H	
⊡ 2$\frac{5}{2}$	29	41	11.55	355.6	89	57	41.11	1,105.3								
⊡ 2$\frac{5}{3}$	29	40	58.58	1,803.6	89	58	13.99	376.2	69	43	55	249	43	40	⊡ 2$\frac{5}{5}$	875.0
									265	49	26				St. Luke's Church	
									301	15	21				Union S. H	
									148	44	19				Alliance L. rod	
⊡ 2$\frac{5}{5}$	29	40	48.73	1,500.3	89	58	44.51	1,196.8								
P. B. M. 28	29	39	45.69	1,406.8	89	57	19.98	537.3	188	15	35				Union S. H	

Stone line B. Ms., geographical positions, ***Donaldsonville to Head of Passes, Louisiana*****—Continued.**

[Latitudes and longitudes are derived from C. and G. S. triangulation △'s.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ 27[illegible]	29	39	08.95	275.6	89	56	31.83	8561.	42	36	22	222	36	15	⊡ 23[illegible]	541.5
									29	56	02				Wilkinson's S H	
									317	44	54				St. Joseph Church	
									317	05	32				St. John's Church	
⊡ 2[illegible]	29	38	56.01	1,724.5	89	56	45.46	1,222.8	22	35	48				Wilkinson's S. H	
									284	08	45				St. Joseph Church	
									273	06	20				St. John's Church	
⊡ 2[illegible]	29	38	31.63	973.9	89	56	59.15	1,590.9	30	06	20	210	06	16	⊡ 22[illegible]	463.8
⊡ 2[illegible]	29	38	18.60	572.7	89	57	07.80	209.8	219	44	36				Wilkinson's S. H	
P. B. M. 27	29	38	22.26	685.4	89	55	25.75	692.7	94	09	31				——do	
⊡ 27	29	37	45.64	1,405.5	89	54	06.09	163.8	30	24	47	210	24	43	⊡ 23	454.0
									316	43	29	136	43	49	Bellevue chy	1,539.6
⊡ 2[illegible]	29	37	32.94	1,014.2	89	54	14.64	393.8	299	35	02	119	35	26	——do	1,479.2
⊡ 2[illegible]	29	37	09.36	288.2	89	54	31.14	837.8	42	38	54	222	38	44	⊡ 23	842.5
⊡ 2[illegible]	29	36	49.24	1,516.0	89	54	52.36	1,408.8	255	01	26				Bellevue chy	
P. B. M. 26	29	37	02.65	81.5	89	53	07.37	198.3	111	11	13	291	11	03	——do	559.8
⊡ 2[illegible]	29	37	04.19	129.0	89	51	25.49	685.8	22	26	32	202	26	27	⊡ 23	776.0
⊡ 2[illegible]	29	36	40.90	1,259.2	89	51	36.50	982.0	10	06	01	190	05	59	⊡ 23	849.0
									321	23	37	141	23	58	Celeste chy	1,841.6
									49	53	42	229	53	24	Junior chy	1,286.1
⊡ 2[illegible]	29	36	13.75	423.1	89	51	42.03	1,131.0	24	18	14	204	18	08	⊡ 22	749.5
									294	55	34	114	56	02	Celeste chy	1,431.4
									90	30	03	270	29	53	Junior chy	834.8
⊡ 22	29	35	51.57	1,587.8	89	51	53.50	1,439.7	267	09	23	87	09	52	Celeste chy	1,608.5
P. B. M. 25	29	36	11.62	357.7	89	49	58.18	1,565.6								
⊡ 2[illegible]	29	35	34.28	1,055.4	89	48	26.55	714.5	24	07	39	204	07	33	⊡ 22	869.2
									355	09	54				St. Thomas Church	776.4
									322	55	59				Court House	
⊡ 2[illegible]	29	35	12.04	370.7	89	48	37.95	1,021.4	283	25	33				St. Thomas Church	
⊡ 2[illegible]	29	34	46.28	1,424.9	89	48	52.58	1,415.1	119	36	07	299	35	46	△ Woodland	1,207.0
									28	28	29	208	28	22	22	761.2
									43	29	44				Old chimney	
									112	02	51				Woodland S. H	
⊡ 2[illegible]	29	34	24.54	755.6	89	49	06.06	163.1	150	17	49	330	17	35	△ Woodland	1,490.8
									140	54	05				Woodland S. H	
									58	11	46				Old chimney	
									219	24	59				St. Thomas Church	
									254	23	33				Court-house	
P. B. M. 23	29	34	16.13	496.6	89	46	57.03	1,535.1	0	27	41				Magnolia S. H	
									359	14	31				Tower	
									[illegible]						Tank	

⊡ $2\frac{30}{1}$	29	34	00.72	22.2	89	40	00.45	11.8	43	54	04	223	53	51	⊡ $2\frac{1}{0}$	749.2
									48	55	55				Tower	
									50	17	33				Tank	
									115	57	34				Court-house	
⊡ $2\frac{29}{0}$	29	33	43.19	1,329.8	89	46	19.75	531.6								
⊡ $2\frac{1}{0}$	29	33	22.05	678.9	89	46	51.86	1,306.7	52	57	07	232	56	40	⊡ $2\frac{2}{0}$	1,194.7
									44	41	36	224	41	34	Tower	161.7
									151	17	37				Court-house	
⊡ $2\frac{3}{0}$	26	32	58.67	1,806.4	89	47	27.30	734.9	303	26	24	123	26	49	Lower base (new position)	1,623.0
									105	10	26	345	10	15	⊠ Upper base	2,238.3
									234	13	59				Tower	
									231	24	50				Tank	
									172	17	34				Court-house	
Lower base (new position.)	29	32	29.62	911.7	89	46	37.00	996.3	147	47	24	327	46	48	⊠ Upper base	3,614.7
									161	01	59				Tower	
P. B. M. 22	29	32	48.42	1,489.8	89	45	31.71	853.7	112	02	45				....do....	
⊡ $2\frac{1}{1}$	29	32	30.03	924.6	89	43	46.42	1,249.7	357	56	26				Gable of red house	
⊡ $2\frac{2}{1}$	29	32	11.37	350.1	89	44	06.79	182.8	323	09	31				St. Patricks Church	
									295	35	20				Gable of red house	
⊡ $2\frac{3}{1}$	29	31	45.30	1,394.7	89	44	22.60	608.5	38	20	05	218	20	00	⊡ $2\frac{1}{1}$	463.1
									124	42	32				Tower	
⊡ $2\frac{3}{2}$	29	31	33.50	1,031.4	89	44	33.27	895.8	127	55	30				Red house chimney	
⊡ $2\frac{1}{2}$	29	30	05.76	177.3	89	41	59.68	1,607.5	48	27	00	228	26	49	⊡ $2\frac{2}{2}$	816.6
									45	23	35				Chimney	
⊡ $2\frac{3}{2}$	29	29	48.17	1,483.1	89	42	22.36	602.3	40	11	15	220	11	05	⊡ $2\frac{2}{2}$	815.5
⊡ $2\frac{1}{3}$	29	29	27.93	860.0	89	42	41.90	1,128.8	307	26	58				St. Patricks Church	
									297	11	56				James Church	
P. B. M. 21	29	31	21.79	670.9	89	43	03.97	106.9	147	00	19				⊠ Union	
									54	06	57				Chimney	
									150	52	42				Church gable	
P. B. M. 20	29	29	13.83	425.8	89	41	16.03	431.8	57	46	02				James Church	
P. B. M. 19	29	27	57.17	1,760.2	89	39	11.30	304.5								
⊡ $2\frac{1}{3}$	29	28	43.80	1,348.6	89	40	12.44	335.1	40	54	18	220	54	12	⊡ $2\frac{3}{3}$	463.0
									23	00	27	203	00	17	St. Patricks Church	1,414.9
⊡ $2\frac{2}{3}$	29	28	32.44	998.8	89	40	23.69	638.2	40	53	02	220	52	52	⊡ $2\frac{3}{3}$	870.0
									14	41	53	194	41	49	St. Patricks Church	984.7
⊡ $2\frac{1}{3}$	29	28	11.07	340.8	89	40	44.83	1,207.9	39	12	19	219	12	12	⊡ $2\frac{3}{3}$	579.9
									184	59	01				M. E. Church	
⊡ $2\frac{3}{4}$	29	27	56.47	1,738.7	89	40	58.44	1,574.6	257	16	51	77	17	04	St. Patricks Church	703.6
⊡ $2\frac{2}{4}$	29	27	50.00	1,539.4	89	37	29.01	781.6	119	03	18	209	03	16	Wesley Church	141.2
⊡ $2\frac{1}{4}$	29	27	15.80	486.5	89	37	35.28	950.8	2	20	05	182	20	05	⊡ $2\frac{4}{4}$	407.4
⊡ $2\frac{3}{4}$	29	27	02.58	79.4	89	37	35.90	967.5								
P. B. M. 18	29	27	12.65	389.5	89	36	16.74	451.1								
⊡ $2\frac{4}{5}$	29	25	30.06	925.5	89	36	04.98	134.2	90	07	47	270	07	32	⊡ $2\frac{5}{5}$	792.6
⊡ $2\frac{1}{5}$	29	25	30.11	927.1	89	36	34.38	926.7	68	40	43	248	40	35	⊡ $2\frac{1}{5}$	490.4
⊡ $2\frac{3}{5}$	29	25	24.32	748.8	89	36	51.33	1,383.8								
P. B. M. 17	29	24	30.72	945.8	89	35	55.83	1,505.1								
⊡ $2\frac{1}{6}$	29	23	41.98	1,292.5	89	34	52.65	1,419.5	37	56	32	217	56	27	⊡ $2\frac{3}{6}$	441.9
									85	07	41				Church spire	
⊡ $2\frac{2}{6}$	29	23	30.66	944.0	89	35	02.72	73.3	42	52	58	222	52	47	⊡ $2\frac{3}{6}$	897.8
									61	52	20				⊠ Decker	966.2
									132	10	34	312	10	28	⊠ Darkey	441.6

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation (△)'s.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ [illegible]	29	23	09.29	286.0	89	35	25.38	684.4								
P. B. M. 16	29	22	52.82	1,626.3	89	34	03.86	104.1	149	24	56	329	24	55	△ Grand Prairie	116.3
⊡ [illegible]	29	22	18.91	582.2	89	32	37.73	1,017.6	18	02	12	198	02	07	⊡ [illegible]	897.9
									324	46	35	144	46	49	Buras Church	1,368.7
⊡ [illegible]	29	21	51.19	1,576.1	89	32	48.03	1,295.4	259	01	21				△ Quarantine	
P. B. M. 14	29	21	41.54	1,279.0	89	30	47.22	1,273.5								
⊡ [illegible]	29	21	10.63	327.3	89	29	50.26	1,355.8	22	08	20	202	08	14	⊡ [illegible]	
⊡ [illegible]	29	20	44.67	1,375.3	89	30	02.32	62.6	133	34	14				△ Quarantine	
P. B. M. 13	29	21	03.07	94.5	89	28	28.89	779.3	33	06	18	213	06	06	△ Taylor	1,248.1
⊡ [illegible]	29	21	54.99	1,693.1	89	27	41.15	1,109.8	333	50	51	153	50	58	⊡ [illegible]	855.8
									180	21	45	0	21	45	NE. cor. Ft. St. Philip	1,132.5
									321	06	45	141	06	46	SE. cor. Ft. St. Philip	50.4
									69	05	10	249	05	04	Flagstaff Ft. St. Philip	350.4
⊡ [illegible]	29	21	30.04	924.9	89	27	27.16	732.5	168	59	01	348	58	55	NE. cor. Ft. St. Philip	
									132	23	19	312	23	06	Flagstaff Ft. St. Philip	953.9
Monument S. E. cor. Ft. St. Philip	29	21	53.72	1,654.0	89	27	39.98	1,078.3	334	38	32	154	38	38	⊡ [illegible]	
									178	48	32	358	48	32	NE. cor. Ft. St. Philip	1,171.8
Monument N. E. cor. Ft. St. Philip	29	22	31.77	978.1	89	27	40.88	1,102.4	76	33	10	256	33	03	Flagstaff Ft. St. Philip	
Monument southwest corner Fort Jackson	29	20	58.09	1,788.5	89	28	00.82	22.1	14	53	28	194	53	22	do	
									187	07	29				Flagstaff Fort St. Philip	
									198	10	37				Southeast corner Fort St. Philip.	
									196	50	51				⊡ [illegible]	
⊡ [illegible]	29	21	18.08	556.7	89	24	45.70	1,232.8								
⊡ [illegible]	29	20	50.26	1,547.4	89	25	03.45	93.1								
P. B. M. 8	29	19	55.79	1,717.7	89	23	52.53	1,417.3								
⊡ [illegible]	29	19	09.48	291.9	89	22	31.25	843.2	53	37	39	233	37	31	⊡ [illegible]	841.2
⊡ [illegible]	29	18	53.29	1,640.7	89	22	56.33	1,520.0								
P. B. M. 7	29	17	30.37	935.1	89	21	51.80	1,398.0								
⊡ [illegible]	29	16	57.99	1,785.5	89	20	43.43	1,172.3	41	46	56	221	46	43	⊡ [illegible]	1,059.1
									20	34	57				Jump Tower	
⊡ [illegible]	29	16	32.34	995.7	89	21	09.57	258.3	312	11	34				do	
P. B. M. 6	29	15	32.94	1,014.2	89	19	51.24	1,383.4								
⊡ [illegible]	29	15	02.23	68.7	89	18	29.16	787.3	49	43	52	229	43	40	⊡ [illegible]	838.5
⊡ [illegible]	29	14	44.63	1,374.1	89	18	52.85	1,427.1								
⊡ [illegible]	29	13	03.13	96.4	89	16	46.75	1,262.7	64	32	09	244	31	50	⊡ [illegible]	1,173.5
									333	54	49	153	54	58	△ Quarantine	1,119.9
⊡ [illegible]	29	12	46.74	1,439.1	89	17	25.97	701.4	302	02	22				△ North	
									287	53	31	107	53	55	△ Quarantine	1,630.9
⊡ [illegible]	29	10	52.84	1,626.9	89	15	23.49	634.7	353	13	52				Head Passes Light	
									245	16	48	65	16	48	Pilots Tower	22.0
									63	21	32	243	21	08	⊡ [illegible]	1,499.6

| | | |

APPENDIX 3 D.

REPORT OF ASSISTANT ENGINEER JAMES A. PAIGE ON PRECISE LEVELING BETWEEN HEAD OF PASSES AND DONALDSONVILLE, LA.

OFFICE MISSISSIPPI RIVER COMMISSION,
St. Louis, May 10, 1893.

SIR: I have the honor to report as follows on the precise leveling operations between the Head of Passes and New Orleans.

Your instructions were to run a line of precise levels from the gauge and other bench marks at the Head of Passes to New Orleans, and there connect with certain bench marks established by the Commission when the line of precise levels was run from Biloxi to Carrollton in 1882; the work to be done by two field-leveling parties equipped in the usual manner, and the necessary force to be quartered on the U. S. S. *Patrol*, Assistant Engineer A. T. Morrow in charge, who at the same time would make a certain survey between Head of the Passes and New Orleans.

I left St. Louis for New Orleans January 11, 1893, and reached the *Patrol* at Kennerville, La., January 12, in company with Assistant E. J. Thomas, Recorder W. S. Williams, and Rodmen Joseph Sheehan and H. M. Conradt. The remainder of the men were assigned from Mr. Morrow's force on the *Patrol*, who had at this time about completed his work to New Orleans, working southward from Donaldsonville.

After the necessary preparation the *Patrol* proceeded from New Orleans on January 17 and arrived at Fort Jackson the same evening, where she was delayed by high winds till the morning of January 20. The Head of Passes was reached that day at noon and the regular fieldwork began there the same evening. The work was completed to New Orleans and all connections made on March 15, 1893, and on the 16th, in company with Mr. Thomas, I returned to St. Louis. Subsequent to this time Mr. Thomas and myself have been engaged in making the office reduction of the season's notes. While the *Patrol* was lying at Fort Jackson a certain bench mark of the vitrified clay and iron-pipe pattern was established there and connections made with it. This is referred to hereafter and is designated in the tabulated results as "Experimental BM."

The leveling force consisted of two field parties organized the same as heretofore on this kind of work, and comprised for one party: James A. Paige, leveler; A. O. Wheeler, recorder; two rodmen; two tent and umbrella men. For the other party: E. J. Thomas, leveler; W. S. Williams, recorder; two rodmen; two tent and umbrella men; making twelve men in all.

The methods in the field operations were about the same as have been in use heretofore on this class of work. All lines were duplicated in a direction contrary to that of the first line run.

Each observer duplicated his own work.

The telescope was made level as indicated by the level vial when the rod was read. The order of the back and fore sight was alternated at the successive instrument stations.

Both foot plates and pins were used for rod supports.

The route of the level line was from the gauge at the head of South Pass westward across the head of Southwest Pass to the west bank; thence northward along the west bank of the river to Fort Jackson; thence across the river to Fort St. Phillip on the east bank; thence northward along the east bank of the river to New Orleans, where connections were made with U. S. P. B. Ms. 2 and 3 and B. M. City Stone, "Halfway House."

These three bench marks were in the line of precise levels executed under the Commission between Biloxi and Carrollton in 1882.

U. S. P. B. Ms. 2 and 3 were also connected with the line of precise levels between Mobile and Carrollton, executed by the U. S. Coast and Geodetic Survey in 1886.

For reference to these bench marks see report of the Mississippi River Commission for 1883, p. 129, also Appendix 9 U. S. Coast and Geodetic Survey Report for 1887.

From the Head of Passes to the Jump, a distance of 11¼ miles by the levels, the surface of the ground leveled over was from 8 to 30 inches above mean tide. The bank here on the west side has a fringe of timber and heavy undergrowth and is composed of vegetable mold and a river deposit of very fine material which, of course, in this part of the Mississippi Valley contains little or no sand. It holds the moisture well and in general presents poor conditions for precise leveling purposes. However, about 80 per cent of the turning points on this stretch consisted of nails in trees and stumps and the results are satisfactory. From the Jump to New Orleans the levels follow the levee and wagon road all the way and it was good ground to work over. Other conditions incidental to the work were tolerably favorable. The principal trouble during the first part of the season was the prevalence of fogs. The difficulty did not arise from interruption of work exactly, but from the sudden

appearance of hot winds. If the fog was light work would be in progress and a hot wind appearing would instantly absorb the fog and change the temperature several degrees. This, of course, would change the refraction very suddenly. Great care had to be taken that the sights at an intrument station were taken under similar conditions in this respect.

The permanent bench marks established were of the pattern heretofore used by the Commission, vitrified clay slabs buried in the ground with a copper bolt leaded in the center, and over which is set an iron pipe 4 feet long and projecting from 6 to 18 inches above the surface of the ground. They were set about 3 miles apart and varying from 20 to 200 meters from the river. This, in view of the fact that there is very little change in this region due to caving banks, and also that a dry and solid foundation for the bench marks, was only found near the river front.

The stone-line bench marks which were also established during the progress of this survey, and of the same pattern as the precise level bench marks, were set about once in every 3 miles of river distance. A P. B. M. was set approximately midway between consecutive stone lines.

The bench marks of a permanent nature will thus average about 1½ miles apart.

The following is a summary of the bench marks established and connected with (not including the temporary bench marks set for the purpose of checking the work):

Precise bench marks established (vitrified clay and iron pipe)	32
Other precise bench marks established (of miscellaneous nature)	5
Other precise bench marks established (copper bolts in various structures)	9
Precise bench marks connected with (of former precise levels)	3
Ordinary level bench marks connected with (of former surveys)	6
Stone-line bench marks connected with	28
Water gauges connected with	3
Total	86

There has been considerable discussion of the stability of bench marks established in surveys of this kind. The sinking of the structure is a defect, more or less, of all forms of permanent bench marks except those established in the natural rock.

The pattern now used by the Commission appears to be the best yet devised when all questions are considered. It is within the possibilities that at some future time the line from New Orleans to the Passes may be releveled, with a view of investigating the question of the gradual subsidence or elevation of that part of the Mississippi Valley. We can assume if a settling of bench marks does occur that it will increase in amount going southward from New Orleans. This would be the supposition, considering the nature of the deposit and the decreasing elevation above the river. A small movement of the bench marks would thus vitiate the comparison of results with those of a line of precise levels run at some future period. In fact, it might lead to wrong conclusions altogether. Many of the precise bench marks established on this survey were set in soft mud even when the best locations were selected. They were always well rammed down and the earth well filled in before being observed to.

On January 18 a bench mark was set at Fort Jackson, about 18 inches beneath the surface of the ground. It was well rammed down in the mud and water and then connected with a reliable bench mark on a tree near by. The earth was then filled in over it. On February 3 it was again observed to before the earth over it was disturbed. On February 5 the earth was taken off and the bench mark again connected with. The results indicate that between the first and second observations, during which time the earth was filled in and sixteen days elapsed, the bench mark sank about 4.8 millimeters; and between the second and third observations, during which time the earth was removed and three days elapsed, that the bench mark rose about 3.8 millimeters.

The results of February 3 and 5 were hardly those expected. However, this is all right as far as it goes, but the experiment covered a period of only eighteen days.

From the weight of the bench mark and its area it is generally supposed that about all of the movement takes place shortly after being set—say, the first thirty days.

It would be interesting to compare the results now obtained with those of a similar line of levels run over the same ground at some future time.

Results.—The final reduction has been compared with the field computations, and a few unimportant errors found.

In the fieldwork the collimation of the wires and the inclination of the level vial were examined each day, and it was attempted to keep the adjustment errors close to zero. The inequality of telescope collars was determined twice during the season for each instrument. The aggregate of these errors constitute a correction to be applied to the excess in length of back or fore sights between consecutive bench marks. If the sum of these corrections for collimation, inclination, and pivot error

amounted to one-tenth of a millimeter or more on any stretch the correction applied in the office reduction. In the entire line there were nine cases where t corrections changed the final elevation of a bench mark by 0.1 of a millimet more. The greatest accumulated amount due to these corrections was at the en the season and amounted to +0.7 millimeters; that is, if no corrections had applied for adjustment errors the elevation of the last bench mark would been seven-tenths of a millimeter less than the one now given.

These results show that the methods in use on this work render the adjust errors of very little importance. The limit of discrepancy between two lines between bench marks was $3^{mm}\sqrt{2K}$, K being the distance between bench mar kilometers.

From the gauge at the head of South Pass to the bench mark at Metairie Ceme New Orleans was a distance of: Main line 164.270 kilos, equal 102.09 miles; lines 17.705 kilos, equal 11.00 miles; total 181.975 kilos, equal 113.09 miles. probable error of the determination of the final bench mark was 8.9 millime This gave a computed probable error per kilometer for the entire line of 0.69 m meters.

An inspection of the results show a gradual divergence of the two lines. The amount at New Orleans being 65.5 millimeters. This has no effect on the res however, except to make the computed probable error somewhat too large.

When two lines were run between bench marks, if they agreed within the scribed limits they were taken for the result for that stretch.

No extra lines were run for the purpose of reducing the probable error. T were two stretches run three times due to error in recording the notes, the and fore sight being transposed.

Two stretches were run four times due to error in the field computations. lecting these cases we have the following summary from the tabulated results:

	No. of stretches.	Kilo meters.	Per of li
Lines run four times	7	6.708	
Lines run two times	145	157.562	
Total	152	164.270	

	No. of stretches.	Kilo-meters.	Per of li
Discrepancies exceeding $3^{mm}\sqrt{2K}$	7	6.708	
Discrepancies within $3^{mm}\sqrt{2K}$	20	29.484	
Discrepancies within $2^{mm}\sqrt{2K}$	54	58.849	
Discrepancies within $1^{mm}\sqrt{2K}$	65	69.229	
Total	152	164.270	

There were three river crossings made by the reciprocal method and the result as reliable as those on other parts of the line; the first was at the head of So west Pass between TBMs. 2 and 3. The second was across the Jump between T 24 A and 24 B, and the third at Forts Jackson and St. Phillip across the river bet TBMs. 62 and 63.

The following are the instrumental constants:

	Date.	Value in seconds.	Corre in m meter met
Level No. 2, telescope collar, eye end larger	Jan. 19, 1893	3.39	—
Do	Apr. 8, 1893	0.00	
Adopted value, Jan. 19 to Feb. 10, 1893			—
Adopted value, Feb. 11 to Mar. 15, 1893			—
Level No. 5, telescope collar, eye end larger	Jan. 19, 1893	2.01	—
Level No. 5, telescope collar, eye end smaller	Apr. 8, 1893		+
Adopted value, Jan. 19 to Feb. 10, 1893			—
Adopted value, Feb. 11 to Mar. 15, 1893			+
Level vial, "Fauth," one division	Jan. 19, 1893	3.03	
Adopted value for the season			
Level vial Kern No. 5, one division, Jan. 19, 1893		2.14	
Adopted value for the season			

Level No. 2, Stadia interval: From January 19 to February 19, 1893, 4.286 millimeters intercepted on rod equal 1 meter; from February 20 to March 15, 1893, 4.224 millimeters intercepted on rod equal 1 meter.

Level No. 5, Stadia interval: For the entire season, 5.026 millimeters intercepted on rod equal 1 meter.

Rod 10, corrections for A — 55.3 millimeters.
Rod 13, corrections for A — 55.3 millimeters.
Rod 18, corrections for A — 55.8 millimeters.
Rod 19, corrections for A — 55.8 millimeters.

No rod correction has been applied as the range in elevation of the bench marks is so small the correction can be neglected. The rods have been taken at standard lengths.

In the tabulation of results the reductions have been made from the bench mark, City Stone "Halfway House" at Metairie Cemetery, New Orleans, to the gauge at the head of South Pass. This bench mark is the starting point, and its elevation is that given in the report of the Mississippi River Commission for 1883, p. 129, being 7.3870 meters referred to the Cairo datum plane.

Column 1 gives the consecutive bench marks in the order in which the various elevations were deduced.

Column 2 gives the distance of any bench mark under consideration from the starting point.

Column 3 gives the direction which the lines were run, N. being north and S. being south.

Column 4 gives the difference in elevation between the bench marks named in column 1; also the mean difference.

Column 5 gives the residuals found by subtracting each result from the mean result.

Column 6 gives the probable error in the result for each stretch.

Column 7 gives the probable error in the result for each permanent bench mark, when referrred to the first bench mark or starting point.

Column 8 gives the elevation of the second bench mark named in column 1.

Column 9 gives the same data as column 8, but reduced to feet.

Column 10 indicates the observer, P. being for Paige, T. for Thomas, and W. for Williams.

In computing the probable error per kilometer (giving 0.69^{mm}) the theoretical assumption is that the various stretches are 1 kilometer in length each. The average length of the stretches is 1,074 meters.

In reference to the three bench marks in New Orleans which were in the line of precise levels of 1882 and which were connected with this Survey (1893).

For B. M. City Stone "Halfway House" at Metairie Cemetery and U. S. P. B. M. 2 at St. Johns Bayou, the two results for 1882 and 1893 differ by 0.7 millimeters, but from U. S. P. B. M. 2 to U. S. P. B. M. 3 at the Fair grounds the results differ by 8.2 millimeters. This indicates that U. S. P. B. M. 3 has settled about 8 millimeters, if the other two bench marks have remained as they were in 1882.

U. S. P. B. M. 3 is in a brick column 4 feet square and about 9 feet high. It was erected about 25 years ago or 14 years previous to the time P. B. M. 3 was established. An inspection of the three bench marks would lead one to regard them all equally reliable. Nothing could be learned as to the depth of foundation for this brick column.

As before stated, the reductions start with the 1882 elevation of B. M. City Stone "Halfway House" at Metairie Cemetery, as this was thought preferable to an adjustment of all the elevations of the three bench marks.

Assistant Thomas's duties in the field were much interfered with by bad health. I consider him a careful and skillful observer on this kind of work.

Respectfully submitted.

JAMES A. PAIGE,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A., Secretary.

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893.

By Assistant Engineers Jas. A. Paige and E. J. Thomas.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
Zero of South Pass Gauge ..	0.000	.....	.....	.....	.....	.....	5.8292	19.125	
3.5 foot mark on gauge.....	0.000	.....	+1.0668	.....	.....	.....	6.8960	22.625	
3.5 foot mark on gauge to T. B. M. 1.....	0.144	N.....	+0.1240	+ 0.4	.....	.....	.....	.....	T.
		S.....	+0.1247	— 0.3	.....	.....	.....	.....	T.
		Mean.	+0.1244		0.2	.....	7.0204	23.033	
T. B. M. 1 to B. M. in Lighthouse	0.157	N.....	+1.1232	+ 0.2	.....	.....	.....	.....	T.
		S.....	+1.1227	— 0.3	.....	.....	.....	.....	T.
		Mean.	+1.1234		0.2	0.3	8.1438	26.719	
T. B. M. 1 to P. B. M.....	0.190	N.....	—0.5073	— 0.3	.....	.....	.....	.....	P.
		S.....	—0.5078	+ 0.3	.....	.....	.....	.....	P.
		Mean.	—0.5076		0.2	0.3	6.5128	21.368	
T. B. M. 1 to P. B. M. 1 A.....	0.190	N.....	+0.6972	+ 0.2	.....	.....	.....	.....	P.
		S.....	+0.6975	— 0.1	.....	.....	.....	.....	P.
		Mean.	+0.6974		0.1	0.2	7.7178	25.321	
T. B. M. 1 to 4-foot mark on old gauge	0.190	N.....	+0.0638	+ 0.4	.....	.....	.....	.....	P.
		S.....	+0.0645	— 0.3	.....	.....	.....	.....	P.
		Mean.	+0.0642		0.2	.....	7.0846	23.244	
Zero of old gauge	.....	.....	—1.2192	.....	.....	.....	5.8654	19.244	
B. M. in Lighthouse to P. B. M. 2.....	0.185	N.....	—0.1140	+ 0.8	.....	.....	.....	.....	P.
		S.....	—0.1123	— 0.9	.....	.....	.....	.....	P.
		Mean.	—0.1132		0.6	0.7	8.0306	26.347	
T. B. M. 1 to T. B. M. 2.....	0.269	N.....	+0.0945	— 0.1	.....	.....	.....	.....	P.
		S.....	+0.0942	+ 0.2	.....	.....	.....	.....	P.
		Mean.	+0.0944		0.1	.....	7.1148	23.343	
T. B. M. 2 to T. B. M. 3.....	1.010	S.....	+0.1137		.....	.....	.....	.....	P.
		N.....	+0.1440		.....	.....	.....	.....	T.
		Mean.	+0.1288	— 0.8	.....	.....	.....	.....	
		N.....	+0.2029		.....	.....	.....	.....	P.
		S.....	+0.0515		.....	.....	.....	.....	T.
		Mean.	+0.1272	+ 0.8	.....	.....	.....	.....	
			+0.1280		0.5	.....	7.2428	23.763	
T. B. M. 3 to T. B. M. 4.....	2.242	N.....	—0.4873	— 1.1	.....	.....	.....	.....	T.
		S.....	—0.4895	+ 1.1	.....	.....	.....	.....	T.
		Mean.	—0.4884		0.7	.....	6.7544	22.160	
T. B. M. 4 to T. B. M. 5.....	2.946	N.....	+0.2033	+1.2	.....	.....	.....	.....	T.
		S.....	+0.2018	—0.3	.....	.....	.....	.....	T.
		N.....	+0.2053	—0.8	.....	.....	.....	.....	T.
		S.....	+0.2047	—0.2	.....	.....	.....	.....	T.
		Mean.	+0.2045	.....	0.3	.....	6.9589	22.831	
T. B. M. 5 to P. B M. 3.....	2.961	N.....	0.2555	+0.1					
		S.....	0.2553	— 0.1					
		Mean	0.2554	.....	0.1	0.9	6.7035	21.993	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 5 to P. B. M. 3 A	2.961	N.....	+0.9438	−0.2					
		S	+0.9435	+0.1					
		Mean.	+0.9436	.....	0.1	0.9	7.3025	25.027	
T. B. M. 5 to T. B. M. 6.....	3.737	N.....	+0.0787	−0.9	.....	.....	.....	.....	P.
		S	+0.0769	+0.9	.....	.....	.....	.....	P.
		Mean.	+0.0778	.....	0.6	.....	7.0367	23.087	
T. B. M. 6 to T. B. M. 7.....	4.547	N.....	+0.2406	+1.8	.....	.....	.....	.....	P.
		S	+0.2442	−1.8	.....	.....	.....	.....	P.
		Mean.	+0.2424	.....	1.2	.....	7.2791	23.882	
T. B. M. 7 to T. B. M. 8.....	4.777	N.....	−0.0710	+0.2	.....	.....	.....	.....	P.
		S	−0.0707	−0.1	.....	.....	.....	.....	P.
		Mean.	−0.0708	.....	0.1	.....	7.2083	23.650	
T. B. M. 8 to B. M. $2\frac{1}{8}$ A.....	4.821	N.....	+0.1870	−0.2	.....	.....	.....	.....	P.
		S	+0.1865	+0.3	.....	.....	.....	.....	P.
		Mean.	+0.1868	.....	0.2	1.7	7.3951	24.262	
T. B. M. 8 to T. B. M. 9.....	5.596	N.....	+0.4190	−0.1	.....	.....	.....	.....	P.
		S	+0.4188	+0.1	.....	.....	.....	.....	P.
		Mean.	+0.4189	.....	0.1	.....	7.6272	25.024	
T. B. M. 9 to T. B. M. 10.....	6.389	N.....	−0.6048	−1.1	.....	.....	.....	.....	P.
		S	−0.6070	+1.1	.....	.....	.....	.....	P.
		Mean.	−0.6059	.....	0.7	.....	7.0213	23.036	
T. B. M. 10 to T. B. M. 11....	6.861	N.....	+0.1650	−0.4	.....	.....	.....	.....	T.
		S	+0.1643	+0.3	.....	.....	.....	.....	T.
		Mean.	+0.1646	.....	0.2	.....	7.1859	23.576	
T. B. M. 11 to P. B. M. 4.....	6.878	N.....	−0.4070	−0.2	.....	.....	.....	.....	T.
		S	−0.4073	+0.1	.....	.....	.....	.....	T.
		Mean.	−0.4072	.....	0.1	1.8	6.7787	22.240	
T. B. M. 11 to P. B. M. 4 A ...	6.878	N.....	+0.7950	−0.2	.....	.....	.....	.....	T.
		S	+0.7947	+0.1	.....	.....	.....	.....	T.
		Mean.	+0.7948	.....	0.1	1.8	7.9807	26.184	
T. B. M. 11 to T. B. M. 12.....	8.008	N.....	+0.0953	+4.5	.....	.....	.....	.....	T.
		S	+0.1021	−2.3	.....	.....	.....	.....	T.
		S	+0.1017	−1.9	.....	.....	.....	.....	T.
		N.....	+0.1000	−0.2	.....	.....	.....	.....	T.
		Mean.	+0.0998	.....	1.0	.....	7.2857	23.903	
T. B. M. 12 to T. B. M. 13.....	8.800	N.....	+0.0853	−0.3	.....	.....	.....	.....	T.
		S	+0.0847	+0.3	.....	.....	.....	.....	T.
		Mean.	+0.0850	.....	0.2	.....	7.3707	24.182	
T. B. M. 13 to T. B. M. 14...	9.586	N.....	−0.0448	−1.8	.....	.....	.....	.....	T.
		S	−0.0483	+1.7	.....	.....	.....	.....	T.
		Mean.	−0.0466	.....	1.2	.....	7.3241	24.029	
T. B. M. 14 to T. B. M. 15...	10.257	N.....	−0.1619	+1.0	.....	.....	.....	.....	P.
		S	−0.1598	−1.1	.....	.....	.....	.....	P.
		Mean.	−0.1609	.....	0.7	.....	7.1632	23.502	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 15 to T. B. M. 16...	10.815	N.....	+0.1329	+0.3	.....	.....	.....	.....	P.
		S	+0.1336	−0.4	.....	.....	.....	.....	P.
		Mean.	+0.1332	.....	0.2	.....	7.2964	23.939	
T. B. M. 16 to T. B. M. 17...	11.757	N.....	+0.2665	−0.4	.....	.....	.....	.....	P.
		S	+0.2657	+0.4	.....	.....	.....	.....	P.
		Mean.	+0.2661	.....	0.3	.....	7.5625	24.812	
T. B. M. 17 to P. B. M. 5....	11.778	N.....	−0.8135	+0.1	.....	.....	.....	.....	P.
		S	−0.8133	−0.1	.....	.....	.....	.....	P.
		Mean.	−0.8134	.....	0.1	2.5	6.7491	22.143	
T. B. M. 17 to P. B. M. 5A...	11.778	N.....	+0.3953	0.0	.....	.....	.....	.....	P.
		S	+0.3953	0.0	.....	.....	.....	.....	P.
		Mean.	+0.3953	.....	0.0	2.5	7.9578	26.108	
T. B. M. 17 to T. B. M. 18...	12.656	N.....	+0.1497	+0.7	.....	.....	.....	.....	P.
		S	+0.1512	−0.8	.....	.....	.....	.....	P.
		Mean.	+0.1504	.....	0.5	.....	7.7129	25.305	
T. B. M. 18 to T. B. M. 19...	13.750	N.....	−0.3209	−0.1	.....	.....	.....	.....	P.
		S	−0.3211	+0.1	.....	.....	.....	.....	P.
		Mean.	−0.3210	.....	0.1	.....	7.3919	24.252	
T. B. M. 19 to T. B. M. 20...	14.847	N.....	−0.0742	+1.1	.....	.....	.....	.....	P.
		S	−0.0721	−1.0	.....	.....	.....	.....	P.
		Mean.	−0.0731	.....	0.7	.....	7.3188	24.012	
T. B. M. 20 to T. B. M. 21...	15.410	N.....	+0.5198	−0.3	.....	.....	.....	.....	P.
		S	+0.5192	+0.3	.....	.....	.....	.....	P.
		Mean.	+0.5195	.....	0.2	.....	7.8383	25.716	
T. B. M. 21 to T. B. M. 22...	16.131	N.....	−0.3394	+0.8	.....	.....	.....	.....	P.
		S	−0.3378	−0.8	.....	.....	.....	.....	P.
		Mean	−0.3386	.....	0.5	.....	7.4997	24.606	
T. B. M. 22 to P. B. M. 6....	16.178	N.....	−0.9368	+0.4	.....	.....	.....	.....	P.
		S	−0.9360	−0.4	.....	.....	.....	.....	P.
		Mean.	−0.9364	.....	0.3	2.7	6.5633	21.533	
T. B. M. 22 to P. B. M. 6A..	16.178	N.....	+0.2702	+0.2	.....	.....	.....	.....	P.
		S	+0.2707	−0.3	.....	.....	.....	.....	P.
		Mean	+0.2704	.....	0.2	2.7	7.7701	25.493	
T. B. M. 22 to T. B. M. 23...	17.982	N.....	−0.1707	+1.8	.....	.....	.....	.....	T.
		S	−0.1672	−1.7	.....	.....	.....	.....	T.
		Mean.	−0.1689	.....	1.2	.....	7.3368	24.051	
T. B. M. 23 to T. B. M. 24...	18.616	N.....	+0.4073	−0.2	.....	.....	.....	.....	T.
		S	+0.4077	+0.2	.....	.....	.....	.....	T.
		Mean.	+0.4075	.....	0.1	.....	7.7383	25.388	
T. B. M. 24 to T. B. M. 24 A...	18.638	N.....	−0.2290	0.0	.....	.....	.....	.....	T.
		S	−0.2290	0.0	.....	.....	.....	.....	T.
		Mean.	−0.2290	.....	0.0	.....	7.5093	24.637	
T. B. M. 24 A to T. B. M. 24 B.	18.788	N.....	−0.1857	.....	.....	.....	.....	.....	T.
		S	−0.1829	.....	.....	.....	.....	.....	P.
		Mean.	−0.1843	−1.0	.....	.....	.....	.....	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
	.....	N.....	−0.1873	.....	.....	.....	.....	.....	P.
		S.....	−0.1854	.....	.....	.....	.....	.....	T.
		Mean.	−0.1863	+1.0	.....	.....	.....	.....	
			−0.1853	.....	0.7	.....	7.3240	24.029	
T. B. M. 24 B to T. B. M. 25...	19.011	N.....	+0.0356	+0.4	.....	.....	.....	.....	T.
		S.....	+0.0363	−0.3	.....	.....	.....	.....	T.
		Mean.	+0.0360	.....	0.2	.....	7.3600	24.147	
T. B. M. 25 to B. M. $2\frac{1}{2}$.....	19.104	N.....	−0.3210	−0.4	.....	.....	.....	.....	T.
		S.....	−0.3217	+0.3	.....	.....	.....	.....	T.
		Mean.	−0.3214	.....	0.2	3.1	7.0386	23.093	
T. B. M. 25 to B. M. $2\frac{1}{2}$A.....	19.104	N.....	+0.8840	−0.5	.....	.....	.....	.....	T.
		S.....	+0.8830	+0.5	.....	.....	.....	.....	T.
		Mean.	+0.8835	.....	0.3	3.1	8.2435	27.046	
T. B. M. 25 to T. B. M. 26.....	20.247	N.....	+0.3902	−0.4	.....	.....	.....	.....	T.
		S.....	+0.3893	+0.5	.....	.....	.....	.....	T.
		Mean.	+0.3898	.....	0.3	.....	7.7498	25.426	
T. B. M. 26 to T. B. M. 27.....	21.238	N.....	−0.6813	+0.1	.....	.....	.....	.....	P.
		S.....	−0.6812	0.0	.....	.....	.....	.....	P.
		Mean.	−0.6812	.....	0.0	.....	7.0686	23.191	
T. B. M. 27 to P. B. M. 7.....	21.345	N.....	−0.3670	+0.4	.....	.....	.....	.....	P.
		S.....	−0.3663	−0.3	.....	.....	.....	.....	P.
		Mean.	−0.3666	.....	0.2	3.1	6.7020	21.988	
T. B. M. 27 to P. B. M 7A	21.345	N.....	+0.8362	−0.1	.....	.....	.....	.....	P.
		S.....	+0.8360	+0.1	.....	.....	.....	.....	P.
		Mean.	+0.8361	.....	0.1	3.1	7.9047	25.934	
T. B. M. 27 to T. B. M. 28.....	22.890	N.....	+0.3527	+0.9	.....	.....	.....	.....	P.
		S.....	+0.3544	−0.8	.....	.....	.....	.....	P.
		Mean.	+0.3536	.....	0.6	.....	7.4222	24.351	
T. B. M. 28 to T. B. M. 29.....	24.012	N.....	+0.3003	+2.0	.....	.....	.....	.....	T.
		S.....	+0.3043	−2.0	.....	.....	.....	.....	T.
		Mean.	+0.3023	.....	1.3	.....	7.7245	25.343	
T. B. M. 29 to T. B. M. 30.....	25.250	N.....	−0.1917	+1.6	.....	.....	.....	.....	P.
		S.....	−0.1886	−1.5	.....	.....	.....	.....	P.
		Mean.	−0.1901	.....	1.0	.....	7.5344	24.719	
T. B. M. 30 to T. B. M. 30A...	25.941	N.....	+0.5620	−0.4	.....	.....	.....	.....	T.
		S.....	+0.5560	+5.6	.....	.....	.....	.....	T.
		N.....	+0.5633	−1.7	.....	.....	.....	.....	T.
		S.....	+0.5652	−3.6	.....	.....	.....	.....	T.
		Mean.	+0.5616	.....	1.2	.....	8.0960	26.562	
T. B. M. 30A to T. B. M. 31...	26.846	N.....	−0.7032	+0.2	.....	.....	.....	.....	T.
		S.....	−0.7027	−0.3	0.2	.....	7.3930	24.255	T.
		Mean.	−0.7030	.....	.....	.....	.....	.....	
T. B. M. 31 to P. B. M. 8.....	26.866	N.....	−0.4360	+0.2	.....	.....	.....	.....	T.
		S.....	−0.4357	−0.1	.....	.....	.....	.....	T.
		Mean.	−0.4358	.....	0.1	3.8	6.9572	22 826	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 31 to P. B. M. 8A	26.866	N	+0.7687	+0.3					T.
		S	+0.7693	−0.3					T.
		Mean	+0.7690		0.2	3.8	8.1620	26.778	
T. B. M. 31 to T. B. M. 32	27.893	N	−0.0560	+0.4					T.
		S	−0.0552	−0.4					T.
		Mean	−0.0556		0.3		7.3374	24.073	
T. B. M. 32 to T. B. M. 33	28.554	N	+0.7338	+1.0					P.
		S	+0.7359	−1.1					P.
		Mean	+0.7348		0.7		8.0722	26.484	
T. B. M. 33 to T. B. M. 56	29.652	N	−0.6186	−1.4					P.
		S	−0.6215	+1.5					P.
		Mean	−0.6200		1.0		7.4522	24.450	
T. B. M. 56 to B. M. 2½	29.942	N	−0.6665	−0.5					P.
		S	−0.6675	+0.5					P.
		Mean	−0.6670		0.3	4.0	6.7852	22.261	
T. B. M. 56 to B. M. 2½A	29.942	N	+0.5313	−0.1					P.
		S	+0.5312	0.0					P.
		Mean	+0.5312		0.0	4.0	7.9834	26.192	
T. B. M. 56 to T. B. M. 57	30.510	N	+0.0342	+0.8					P.
		S	+0.0358	−0.8					P.
		Mean	+0.0350		0.5		7.4872	24.565	
T. B. M. 57 to T. B. M. 58	31.435	N	+0.5837	−0.9					P.
		S	+0.5820	+0.8					P.
		Mean	+0.5828		0.6		8.0700	26.477	
T. B. M. 58 to P. B. M. 9	31.450	N	−1.1320	−0.1					P.
		S	−1.1318	+0.1					P.
		Mean	−1.1319		0.1	4.1	6.9381	22.763	
T. B. M. 58 to P. B. M. 9A	31.450	N	+0.0725	−0.4					P.
		S	+0.0770	+0.4					P.
		Mean	+0.0721		0.3	4.1	8.1421	26.713	
T. B. M. 58 to T. B. M. 59	32.569	N	−0.9017	+0.5					T.
		S	−0.9007	−0.5					T.
		Mean	−0.9012		0.3		7.1688	23.520	
T. B. M. 59 to T. B. M. 60	33.727	N	+0.6350	+0.5					T.
		S	+0.6360	−0.5					T.
		Mean	+0.6355		0.3		7.8043	25.605	
T. B. M. 60 to 7-foot mark, Fort Jackson gauge	33.898	N	+0.2000	−0.8					P.
		S	+0.1983	+0.9					P.
		Mean	+0.1992		0.6	4.1	8.0035	26.258	
Zero of Fort Jackson gauge	33.898		−2.1335				5.8700	19.258	
T. B. M. 60 to B. M. in hospital	33.860	N	−0.1680	−1.3					P.
		S	−0.1706	+1.3					P.
		Mean	−0.1693		0.9	4.2	7.6350	25.049	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 60 to B. M. in ordnance sergeant's quarters.	33.833	N.....	+0.0430	−0.2	.....	.....	.....	.....	P.
		S.....	+0.0433	+0.1	.....	.....	.....	.....	P.
		Mean.	+0.0432	.....	0.1	4.1	7.8475	25.747	
T. B. M. 60 to T. B. M. 10 ...	33.759	N.....	−0.2657	−0.1	.....	.....	.....	.....	P.
		S.....	−0.2660	+0.2	.....	.....	.....	.....	P.
		Mean.	−0.2658	.....	0.1	4.1	7.5385	24.733	
T. B. M. 60 to T. B. M. 61....	34.264	N.....	−0.0943	+0.7	.....	.....	.....	.....	P.
		S.....	−0.0930	−0.6	.....	.....	.....	.....	P.
		Mean.	−0.0936	.....	0.4	.....	7.7107	25.298	
T. B. M. 61 to Experimental B. M	34.325	N.....	−1.0640	Jan...	18.	.....	.....	.....	P.
		S.....	−1.0642	Jan...	18.	.....	.....	.....	P.
		N.....	−1.0697	Feb...	3.	.....	.....	.....	P.
		S.....	−1.0683	Feb...	3.	.....	.....	.....	P.
		N.....	−1.0652	Feb...	5.	.....	.....	.....	P.
		Mean.	−1.0663	.....	.....	.....	6.6444	21.799	
T. B. M. 60 to B. M. $\frac{2}{3}^{2}$	33.795	N.....	−0.8667	−0.1	.....	.....	.....	.....	T.
		S.....	−0.8670	+0.2	.....	.....	.....	.....	T.
		Mean.	−0.8668	.....	0.1	4.1	6.9375	22.761	
T. B. M. 60 to B. M. $\frac{2}{3}^{2}$	33.795	N.....	+0.3383	+0.7	.....	.....	.....	.....	T.
		S.....	+0.3397	−0.7	.....	.....	.....	.....	T.
		Mean.	+0.3390	.....	0.5	4.1	8.1433	26.717	
T. B. M. 60 to T. B. M. 62....	33.908	N.....	+0.4930	0.0	.....	.....	.....	.....	T.
		S.....	+0.4930	0.0	.....	.....	.....	.....	T.
		Mean.	+0.4930	.....	0.0	.....	8.2973	27.222	
T. B. M. 62 to T. B. M. 63.....	34.638	N.....	−0.0849	.....	.....	.....	.....	.....	T.
		S.....	−0.1065	.....	.....	.....	.....	.....	T.
		Mean.	−0.0957	−0.7	.....	.....	.....	.....	
		N.....	−0.0727	.....	.....	.....	.....	.....	P.
		S.....	−0.1214	.....	.....	.....	.....	.....	P.
		Mean.	−0.0970	+0.6	.....	.....	.....	.....	
			−0.0964	.....	0.4	.....	8.2009	26.906	
T. B. M. 63 to B. M. $\frac{2}{3}^{2}$	34.871	N.....	−1.0486	−0.3	.....	.....	.....	.....	P.
		S.....	−1.0492	+0.3	.....	.....	.....	.....	P.
		Mean.	−1.0489	.....	0.2	4.1	7.1520	23.465	
B. M. $\frac{2}{3}^{2}$ to P. B. M. 11.....	34.926	N.....	+0.7200	−0.2	.....	.....	.....	.....	P.
		S.....	+0.7196	+0.2	.....	.....	.....	.....	P.
		Mean.	+0.7198	.....	0.1	4.1	7.8718	25.826	
P. B. M. 11 to B. M. $\frac{2}{3}^{2}$ A....	34.981	N.....	+0.4877	+0.1	.....	.....	.....	.....	P.
		S.....	+0.4880	−0.2	.....	.....	.....	.....	P.
		Mean.	+0.4878	.....	0.1	4.1	8.3596	27.427	
T. B. M. 63 to P. B. M. 12.....	34.802	N.....	+0.0392	−0.2	.....	.....	.....	.....	P.
		S.....	+0.0389	+0.1	.....	.....	.....	.....	P.
		Mean.	+0.0390	.....	0.1	4.1	8.2399	27.034	
T. B. M. 63 to T. B. M. 64....	35.507	N.....	−0.3658	+0.7	.....	.....	.....	.....	P.
		S.....	−0.3644	−0.7	.....	.....	.....	.....	P.
		Mean.	−0.3651	.....	0.5	.....	7.8358	25.708	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 64 to T. B. M. 65	36.643	N	−0.3637	+1.7					P.
		S	−0.3603	−1.7					P.
		Mean	−0.3620		1.1		7.4738	24.521	
T. B. M. 65 to P. B. M. 13	36.656	N	−0.1240	0.0					P.
		S	−0.1241	+0.1					P.
		Mean	−0.1240		0.0	4.3	7.3498	24.114	
T. B. M. 65 to P. B. M. 13 A	36.656	N	+1.0867	+0.4					P.
		S	+1.0859	−0.4					P.
		Mean	+1.0863		0.3	4.3	8.5601	28.085	
T. B. M. 65 to T. B. M. 66	37.464	N	+0.0427	−0.3					T.
		S	+0.0422	+0.2					T.
		Mean	+0.0424		0.2		7.5162	24.660	
T. B. M. 66 to T. B. M. 67	38.514	N	+0.4707	+1.1					T.
		S	+0.4730	−1.2					T.
		Mean	+0.4718		0.8		7.9880	26.208	
T. B. M. 67 to T. B. M. 68	38.113	N	+0.3057	+1.5					T.
		S	+0.3087	−1.5					T.
		Mean	+0.3072		1.0		8.2952	27.215	
T. B. M. 68 to B. M. $\frac{2}{3}^{5}$	39.131	N	−1.3438	−0.4					T.
		S	−1.3445	+0.3					T.
		Mean	−1.3442		0.2	4.5	6.9510	22.805	
T. B. M. 68 to B. M. $\frac{2}{3}^{5}$ A	39.131	N	−0.1438	0.0					T.
		S	−0.1437	−0.1					T.
		Mean	−0.1438		0.0	4.5	8.1554	26.757	
T. B. M. 68 to T. B. M. 69	39.930	N	−0.4701	+3.7					T.
		S	−0.4653	−1.1					T.
		N	−0.4645	−1.9					T.
		S	−0.4657	−0.7					T.
		Mean	−0.4664		0.8		7.8288	25.685	
T. B. M. 69 to T. B. M. 70	40.845	N	−0.2643	+3.9					T.
		S	−0.2590	−1.4					W.
		N	−0.2602	−0.2					W.
		S	−0.2583	−2.1					W.
		Mean	−0.2604		0.9		7.5684	24.831	
T. B. M. 70 to P. B. M. 14	40.928	N	−0.8133	0.0					W.
		S	−0.8133	0.0					W.
		Mean	−0.8133		0.0	4.6	6.7551	22.163	
T. B. M. 70 to P. B. M. 14 A	40.928	N	+0.3913	0.0					W.
		S	+0.3913	0.0					W.
		Mean	+0.3913		0.0	4.6	7.9597	26.115	
T. B. M. 70 to T. B. M. 71	41.304	N	+0.0115	−0.5					W.
		S	+0.0125	0.5					W.
		Mean	+0.0120		0.3		7.5804	24.870	
T. B. M. 71 to T. B. M. 72	42.414	N	+0.2063	0.1					P.
		S	+0.2061	+0.1					P.
		Mean	+0.2062		0.1		7.7866	25.547	

Result of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 72 to P. B. M. 15	42.478	N	+0.2449	−0.3					P.
		S	+0.2455	+0.3					P.
		Mean	+0.2452		0.2	4.6	8.0318	26.351	
T. B. M. 72 to T. B. M. 73	44.110	N	−0.3668	−0.2					P.
		S	−0.3672	+0.2					P.
		Mean	−0.3670		0.1		7.4196	24.343	
T. B. M. 73 to B. M. $^{2}_{3}$7	44.176	N	−0.5097	−0.1					P.
		S	−0.5100	+0.2					P.
		Mean	−0.5098		0.1	4.6	6.9098	22.670	
T. B. M. 73 to B. M. $^{2}_{3}$7 A	44.176	N	+0.6925	+0.4					P.
		S	+0.6933	−0.4					P.
		Mean	+0.6929		0.3	4.6	8.1125	26.616	
T. B. M. 73 to T. B. M. 74	46.741	N	+0.4699	−1.9					P.
		S	+0.4661	+1.9					P.
		Mean	+0.4680		1.3		7.8876	25.878	
T. B. M. 74 to P. B. M. 16	46.752	N	−0.9542	+0.4					P.
		S	−0.9533	−0.5					P.
		Mean	−0.9538		0.3	4.8	6.9338	22.749	
T. B. M. 74 to P. B. M. 16 A	46.752	N	+0.2531	−0.5					P.
		S	+0.2520	+0.6					P.
		Mean	+0.2526		0.4	4.8	8.1402	26.707	
T. B. M. 74 to T. B. M. 75	47.898	N	−0.1597	+0.9					P.
		S	−0.1580	−0.8					P.
		Mean	−0.1588		0.6		7.7288	25.357	
T. B. M. 75 to T. B. M. 77	48.741	N	−0.0655	+0.5					P.
		S	−0.0646	−0.4					P.
		Mean	−0.0650		0.3		7.6638	25.144	
T. B. M. 77 to B. M. $^{2}_{3}$4	48.756	N	−0.9427	−0.1					P.
		S	−0.9429	+0.1					P.
		Mean	−0.9428		0.1	4.9	6.7210	22.051	
T. B. M. 77 to B. M. $^{2}_{3}$4 A	48.756	N	+0.2630	−0.2					P.
		S	+0.2626	+0.2					P.
		Mean	+0.2628		0.1	4.9	7.9266	26.006	
T. B. M. 77 to T. B. M. 77 A	49.844	N	−0.4680	+0.6					P.
		S	−0.4667	−0.7					P.
		Mean	−0.4674		0.4		7.1964	23.610	
T. B. M. 77 A to T. B. M. 78	51.094	N	+0.5823	+0.6					P.
		S	+0.5835	−0.6					P.
		Mean	+0.5829		0.4		7.7793	25.523	
T. B. M. 78 to P. B. M. 17	51.109	N	−1.1355	+0.1					W.
		S	−1.1353	−0.1					W.
		Mean	−1.1354		0.1	4.9	6.6439	21.798	
T. B. M. 78 to P. B. M. 17 A	51.109	N	+0.0720	0.0					W.
		S	+0.0720	0.0					W.
		Mean	+0.0720		0.0	4.9	7.8513	25.759	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 110 to T. B. M. 111 ..	88.679	N.....	—0.3839	+0.6	.....	.....	.....	.....	P.
		S	—0.3827	—0.6	.....	.....	.....	.....	P.
		Mean.	—0.3833	.....	0.4	.....	8.0600	26.463	
T. B. M. 111 to B. M. $2\frac{3}{4}^{8}$	88.708	N.....	—0.7773	—0.2	.....	.....	.....	.....	T.
		S	—0.7777	+0.2	.....	.....	.....	.....	T.
		Mean.	—0.7775	.....	0.1	6.6	7.2885	23.913	
T. B. M. 111 to B. M. $2\frac{3}{4}^{8}$ A...	88.708	N.....	+0.4323	0.0	.....	.....	.....	.....	T.
		S	+0.4323	0.0	.....	.....	.....	.....	T.
		Mean.	+0.4323	.....	0.0	6.6	8.4983	27.882	
T. B. M. 111 to T. B. M. 112 ..	90.095	N.....	—0.0066	+2.0	.....	.....	.....	.....	P.
		S	—0.0027	—1.9	.....	.....	.....	.....	P.
		Mean.	—0.0046	.....	1.3	.....	8.0614	26.448	
T. B. M. 112 to T. B. M. 113...	91.231	N.....	+0.8473	+1.5	.....	.....	.....	.....	P.
		S	+0.8504	—1.6	.....	.....	.....	.....	P.
		Mean.	+0.8488	.....	1.0	.....	8.9102	29.233	
T. B. M. 113 to P. B. M. 26...	91.259	N.....	—1.5283	—0.2	.....	.....	.....	.....	T.
		S	—1.5287	+0.2	.....	.....	.....	.....	T.
		Mean.	—1.5285	.....	0.1	6.8	7.3817	24.218	
T. B. M. 113 to P. B. M. 26 A..	91.259	N.....	—0.3180	0.0	.....	.....	.....	.....	T.
		S	—0.3180	0.0	.....	.....	.....	.....	T.
		Mean.	—0.3180	.....	0.0	6.8	8.5922	28.190	
T. B. M. 113 to T. B. M. 114...	93.277	N.....	—0.7810	+0.8	.....	.....	.....	.....	T.
		S	—0.7783	—0.9	.....	.....	.....	.....	T.
		Mean.	—0.7792	.....	0.6	.....	8.1310	26.677	
T. B. M. 114 to B. M. $2\frac{3}{4}^{12}$	93.328	N.....	—1.0870	+0.2	.....	.....	.....	.....	T.
		S	—1.0867	—0.1	.....	.....	.....	.....	T.
		Mean.	—1.0868	.....	0.1	6.8	7.0442	23.111	
T. B. M. 114 to B. M. $2\frac{3}{4}^{12}$ A...	93.328	N.....	+0.1250	—0.5	.....	.....	.....	.....	T.
		S	+0.1240	+0.5	.....	.....	.....	.....	T.
		Mean.	+0.1245	.....	0.3	6.8	8.2555	27.085	
T. B. M. 114 to T. B. M. 115...	94.250	N.....	—0.0370	+0.5	.....	.....	.....	.....	T.
		S	—0.0360	—0.5	.....	.....	.....	.....	T.
		Mean.	—0.0365	.....	0.3	.....	8.0945	26.557	
T. B. M. 115 to T. B. M. 116...	95.040	N.....	—0.1403	+0.3	.....	.....	.....	.....	T.
		S	—0.1397	—0.3	.....	.....	.....	.....	T.
		Mean.	—0.1400	.....	0.2	.....	7.9545	26.098	
T. B. M. 116 to T. B. M. 119...	95.823	N.....	+0.1526	—0.2	.....	.....	.....	.....	T.
		S	+0.1540	—1.2	.....	.....	.....	.....	T.
		S	+0.1517	+1.1	.....	.....	.....	.....	T.
		Mean.	+0.1528	.....	0.3	.....	8.1073	26.599	
T. B. M. 119 to P. B. M. 27....	95.886	N.....	—0.8280	+0.3	.....	.....	.....	.....	P.
		S	—0.8274	—0.3	.....	.....	.....	.....	P.
		Mean.	—0.8277	.....	0.2	6.9	7.2796	23.883	
T. B. M. 119 to P. B. M. 27 A..	95.886	N.....	+0.3804	—0.1	.....	.....	.....	.....	P.
		S	+0.3802	+0.1	.....	.....	.....	.....	P.
		Mean.	+0.3803	.....	0.1	6.9	8.4876	27.847	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 119 to T. B. M. 120...	97.246	N.....	−0.0916	+0.5	.....	.....	.....	.....	P.
		S.....	−0.0906	−0.5	.....	.....	.....	.....	P.
		Mean.	−0.0911	.....	0.3	.....	8.0162	26.300	
T. B. M. 120 to T. B. M. 121...	98.300	N.....	+0.2825	−1.0	.....	.....	.....	.....	P.
		S.....	+0.2805	+1.0	.....	.....	.....	.....	P.
		Mean	+0.2815	.....	0.7	.....	8.2977	27.224	
T. B. M. 121 to B. M. $\frac{2}{3}^{a}$	98.399	N.....	−0.6460	−0.5	.....	.....	.....	.....	P.
		S.....	−0.6470	+0.5	.....	.....	.....	.....	P.
		Mean.	−0.6465	.....	0.3	6.9	7.6512	25.103	
T. B. M. 121 to B. M. $\frac{2}{3}^{a}$ A...	98.399	N.....	+0.5583	−0.3	.....	.....	.....	.....	P.
		S.....	+0.5577	+0.3	.....	.....	.....	.....	P.
		Mean.	+0.5580	.....	0.2	6.9	8.8557	29.054	
T. B. M. 121 to T. B. M. 122...	100.111	N.....	−0.7270	−0.4	.....	.....	.....	.....	P.
		S.....	−0.7279	+0.5	.....	.....	.....	.....	P.
		Mean.	−0.7274	.....	0.3	.....	7.5703	24.837	
T. B. M. 122 to P. B. M. 28....	100.168	N.....	−1.0280	0.0	.....	.....	.....	.....	P.
		S.....	−1.0280	0.0	.....	.....	.....	.....	P.
		Mean.	−1.0280	.....	0.0	6.9	6.5423	21.464	
T. B. M. 122 to P. B. M. 28 A.	100.168	N.....	+0.1797	0.0	.....	.....	.....	.....	P.
		S.....	+0.1797	0.0	.....	.....	.....	.....	P.
		Mean.	+0.1797	.....	0.0	6.9	7.7500	25.427	
T. B. M. 122 to T. B. M. 123...	100.859	N.....	+0.1764	−1.6	.....	.....	.....	.....	P.
		S.....	+0.1731	+1.7	.....	.....	.....	.....	P.
		Mean.	+0.1748	.....	1.1	.....	7.7451	25.411	
T. B. M. 123 to T. B. M. 124...	103.003	N.....	+0.9976	+2.2	.....	.....	.....	.....	P.
		S.....	+1.0021	−2.3	.....	.....	.....	.....	P.
		Mean.	+0.9998	.....	1.5	.....	8.7449	28.691	
T. B. M. 124 to B. M. $\frac{2}{3}^{a}$.....	103.073	N.....	−1.3042	−0.3	.....	.....	.....	.....	P.
		S.....	−1.3048	+0.3	.....	.....	.....	.....	P.
		Mean.	−1.3045	.....	0.2	7.2	7.4404	24.411	
T. B. M. 124 to B. M. $\frac{2}{3}^{a}$ A...	103.073	N.....	−0.0912	+0.4	.....	.....	.....	.....	P.
		S.....	−0.0905	−0.3	.....	.....	.....	.....	P.
		Mean.	−0.0908	.....	0.2	7.2	8.6541	28.393	
T. B. M. 124 to T. B. M. 125...	103.651	N.....	−0.4243	−0.9	.....	.....	.....	.....	T.
		S.....	−0.4260	+0.8	.....	.....	.....	.....	T.
		Mean.	−0.4252	.....	0.6	.....	8.3197	27.296	
T. B. M. 125 to T. B. M. 126...	104.501	N.....	−0.5370	+1.4	.....	.....	.....	.....	T.
		S.....	−0.5340	−1.6	.....	.....	.....	.....	T.
		S.....	−0.5357	+0.1	.....	.....	.....	.....	T.
		Mean.	−0.5356	.....	0.6	.....	7.7841	25.539	
T. B. M. 126 to T. B. M. 127...	105.308	N.....	+0.3177	−1.5	.....	.....	.....	.....	T.
		S.....	+0.3137	+2.5	.....	.....	.....	.....	T.
		N.....	+0.3180	−1.8	.....	.....	.....	.....	T.
		S.....	+0.3153	+0.9	.....	.....	.....	.....	T.
		Mean.	+0.3162	.....	0.7	.....	8.1003	26.576	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 94 to P. B. M. 21	70.691	N	−1.3988	0.0					P.
		S	−1.3988	0.0					P.
		Mean	−1.3988		0.0	6.1	6.9837	22.913	
T. B. M. 94 to P. B. M. 21 A	70.691	N	−0.1930	0.0					P.
		S	−0.1929	−0.1					P.
		Mean	−0.1930		0.0	6.1	8.1895	26.869	
T. B. M. 94 to ⊗ Union	71.199	N	−9.5414	0.0					P.
		S	−0.5415	+0.1					P.
		Mean	−0.5414		0.0	6.1	7.8411	25.726	
T. B. M. 94 to T. B. M. 95	71.679	N	−0.1153	+0.6					P.
		S	−0.1141	−0.6					P.
		Mean	−0.1147		0.4		8.2678	27.126	
T. B. M. 95 to T. B. M. 96	72.945	N	−0.0986	−0.2					P.
		S	−0.0991	+0.3					P.
		Mean	−0.0988		0.2		8.1630	26.801	
T. B. M. 96 to B. M. $\frac{33}{2}$	73.070	N	−1.2730	+0.2					P.
		S	−1.2725	−0.3					P.
		Mean	−1.2728		0.2	6.1	6.8962	22.626	
T. B. M. 96 to B. M. $\frac{33}{2}$ A	73.070	N	−0.0670	−0.6					P.
		S	−0.0682	+0.6					P.
		Mean	−0.0676		0.4	6.1	8.1014	26.580	
T. B. M. 96 to T. B. M. 97	74.537	N	+0.0972	−0.3					P.
		S	+0.0966	+0.3					P.
		Mean	+0.0969		0.2		8.2659	27.119	
T. B. M. 97 to T. B. M. 100	75.871	N	+0.3839	−0.5					P.
		S	+0.3830	+0.4					P.
		Mean	+0.3834		0.3		8.6493	28.377	
T. B. M. 100 to P. B. M. 22	75.897	N	−1.1960	+0.2					T.
		S	−1.1957	−0.1					T.
		Mean	−1.1958		0.1	6.1	7.4535	24.454	
T. B. M. 100 to P. B. M. 22 A	75.897	N	+0.0140	−0.2					T.
		S	+0.0137	+0.1					T.
		Mean	+0.0138		0.1	6.1	8.6631	28.422	
T. B. M. 100 to T. B. M. 101	76.787	N	−0.6387	−1.1					T.
		S	−0.6410	+1.2					T.
		Mean	−0.6398		0.8		8.0095	26.278	
T. B. M. 101 to T. B. M. 102	77.989	N	0.3292	−1.2					T.
		S	−0.3317	+1.3					T.
		Mean	−0.3304		0.8		7.6791	25.194	
T. B. M. 102 to B. M. $\frac{23}{2}$	78.069	N	−0.8153	−0.2					T.
		S	−0.8157	+0.2					T.
		Mean	−0.8155		0.1	6.2	6.8636	22.519	
T. B. M. 102 to B. M. $\frac{23}{2}$ A	78.069	N	+0.3930	+0.2					T.
		S	+0.3933	−0.1					T.
		Mean	+0.3932		0.1	6.2	8.0723	26.484	

***Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893*—Continued.**

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 102 to T. B. M. 103...	79.512	N.....	+0.2878	−2.0					T.
		S.....	+0.2837	+2.1					T.
		Mean.	+0.2858		1.4		7.9649	26.132	
T. B. M. 103 to P. B. M. 23....	79.532	N.....	−0.9190	+0.2					T.
		S.....	−0.9187	−0.1					T.
		Mean.	−0.9188		0.1	6.4	7.0461	23.117	
T. B. M. 103 to P. B. M. 23 A.	79.532	N.....	+0.2920	0.0					T.
		S.....	+0.2920	0.0					T.
		Mean.	+0.2920		0.0	6.4	8.2569	27.090	
T. B. M. 103 to T. B. M. 104...	80.614	N.....	+0.3348	+1.2					T.
		S.....	+0.3372	−1.2					T.
		Mean.	+0.3360		0.8		8.3609	27.234	
T. B. M. 104 to P. B. M. 24....	81.087	N.....	+1.1713	−1.1					T.
		S.....	+1.1692	+1.0					T.
		Mean.	+1.1702		0.7	6.4	9.4711	31.073	
P. B. M. 24 to T. B. M. 105....	82.475	N.....	−1.0815	+0.4					P.
		S.....	−1.0808	−0.3					P.
		Mean.	−1.0811		0.2		8.3900	27.526	
T. B. M. 105 to T. B. M. 106...	82.878	N.....	−0.7468	+0.6					T.
		S.....	−0.7457	−0.5					T.
		Mean.	−0.7462		0.4		7.6438	25.078	
T. B. M. 106 to B. M. $\frac{2}{3}$[2].....	82.889	N.....	−0.5848	+0.2					T.
		S.....	−0.5842	−0.3					T.
		Mean.	−0.5846		0.2	6.5	7.0592	23.160	
T. B. M. 106 to B. M. $\frac{2}{3}$[2] A....	82.889	N.....	+0.6207	0.0					T.
		S.....	+0.6207	0.0					T.
		Mean.	+0.6207		0.0	6.5	8.2645	27.115	
T. B. M. 106 to T. B. M. 107...	84.064	N.....	−0.1430	+0.8					T.
		S.....	−0.1413	−0.9					T.
		Mean.	−0.1422		0.6		7.5016	24.612	
T. B. M. 107 to T. B. M. 108...	85.789	N.....	+0.2587	+1.5					T.
		S.....	+0.2617	−1.5					T.
		Mean.	+0.2602		1.0		7.7618	25.465	
T. B. M. 108 to P. B. M. 25....	85.879	N.....	−0.8233	−0.1					P.
		S.....	−0.8235	+0.1					P.
		Mean.	−0.8234		0.1	6.6	6.9384	22.764	
T. B. M. 108 to P. B. M. 25 A.	85.879	N.....	+0.3838	−0.4					P.
		S.....	+0.3845	+0.3					P.
		Mean.	+0.3842		0.2	6.6	8.1460	26.726	
T. B. M. 108 to T. B. M. 109...	87.331	N.....	+0.4406	+1.1					P.
		S.....	+0.4428	−1.1					P.
		Mean.	+0.4417		0.7		8.2035	26.915	
T. B. M. 109 to T. B. M. 110 ..	88.131	N.....	+0.2456	−0.2					P.
		S.....	+0.2460	0.2					P.
		Mean.	+0.2458		0.1		8.4493	27.721	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 110 to T. B. M. 111	88.679	N	−0.3839	+0.6					P.
		S	−0.3827	−0.6					P.
		Mean	−0.3833		0.4		8.0660	26.463	
T. B. M. 111 to B. M. $2\frac{3}{4}^{8}$	88.708	N	−0.7773	−0.2					T.
		S	−0.7777	+0.2					T.
		Mean	−0.7775		0.1	6.6	7.2885	23.913	
T. B. M. 111 to B. M. $2\frac{3}{4}^{8}$ A	88.708	N	+0.4323	0.0					T.
		S	+0.4323	0.0					T.
		Mean	+0.4323		0.0	6.6	8.4983	27.882	
T. B. M. 111 to T. B. M. 112	90.095	N	−0.0066	+2.0					P.
		S	−0.0027	−1.9					P.
		Mean	−0.0046		1.3		8.0614	26.448	
T. B. M. 112 to T. B. M. 113	91.231	N	+0.8473	+1.5					P.
		S	+0.8504	−1.6					P.
		Mean	+0.8488		1.0		8.9102	29.233	
T. B. M. 113 to P. B. M. 26	91.259	N	−1.5286	−0.2					T.
		S	−1.5287	+0.2					T.
		Mean	−1.5285		0.1	6.8	7.3817	24.218	
T. B. M. 113 to P. B. M. 26 A	91.259	N	−0.3180	0.0					T.
		S	−0.3180	0.0					T.
		Mean	−0.3180		0.0	6.8	8.5022	28.190	
T. B. M. 113 to T. B. M. 114	93.277	N	−0.7830	+0.8					T.
		S	−0.7783	−0.9					T.
		Mean	−0.7792		0.6		8.1310	26.677	
T. B. M. 114 to B. M. $2\frac{7}{4}^{1}$	93.328	N	−1.0870	+0.2					T.
		S	−1.0867	−0.1					T.
		Mean	−1.0868		0.1	6.8	7.0442	23.111	
T. B. M. 114 to B. M. $2\frac{3}{4}^{7}$ A	93.328	N	+0.1250	−0.5					T.
		S	+0.1240	+0.5					T.
		Mean	+0.1245		0.3	6.8	8.2555	27.085	
T. B. M. 114 to T. B. M. 115	94.250	N	−0.0370	+0.5					T.
		S	−0.0360	−0.5					T.
		Mean	−0.0365		0.3		8.0945	26.557	
T. B. M. 115 to T. B. M. 116	95.040	N	−0.1403	+0.3					T.
		S	−0.1397	−0.3					T.
		Mean	−0.1400		0.2		7.9545	26.098	
T. B. M. 116 to T. B. M. 119	95.823	N	+0.1526	−0.2					T.
		S	+0.1540	−1.2					T.
		S	+0.1517	+1.1					T.
		Mean	+0.1528		0.3		8.1073	26.599	
T. B. M. 119 to P. B. M. 27	95.886	N	−0.8280	+0.3					P.
		S	−0.8274	0.3					P.
		Mean	−0.8277		0.2	6.9	7.2796	23.883	
T. B. M. 119 to P. B. M. 27 A	95.886	N	−0.3804	0.1					P.
		S	−0.3802	+0.1					P.
		Mean	−0.3803		0.1	6.9	8.4876	27.847	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 119 to T. B. M. 120...	97.246	N.....	−0.0916	+0.5	.....	.....	.....	.....	P.
		S.....	−0.0906	−0.5	.....	.....	.....	.....	P.
		Mean.	−0.0911	.....	0.3	.....	8.0162	26.300	
T. B. M. 120 to T. B. M. 121...	98.300	N.....	+0.2825	−1.0	.....	.....	.....	.....	P.
		S.....	+0.2805	+1.0	.....	.....	.....	.....	P.
		Mean	+0.2815	.....	0.7	.....	8.2977	27.224	
T. B. M. 121 to B. M. $2\frac{1}{2}^{a}$	98.399	N.....	−0.6460	−0.5	.....	.....	.....	.....	P.
		S.....	−0.6470	+0.5	.....	.....	.....	.....	P.
		Mean.	−0.6465	.....	0.3	6.9	7.6512	25.103	
T. B. M. 121 to B. M. $2\frac{1}{2}^{a}$ A...	98.399	N.....	+0.5583	−0.3	.....	.....	.....	.....	P.
		S.....	+0.5577	+0.3	.....	.....	.....	.....	P.
		Mean.	+0.5580	.....	0.2	6.9	8.8557	29.054	
T. B. M. 121 to T. B. M. 122...	100.111	N.....	−0.7270	−0.4	.....	.....	.....	.....	P.
		S.....	−0.7279	+0.5	.....	.....	.....	.....	P.
		Mean.	−0.7274	.....	0.3	.....	7.5703	24.837	
T. B. M. 122 to P. B. M. 28....	100.168	N.....	−1.0280	0.0	.....	.....	.....	.....	P.
		S.....	−1.0280	0.0	.....	.....	.....	.....	P.
		Mean.	−1.0280	.....	0.0	6.9	6.5423	21.464	
T. B. M. 122 to P. B. M. 28 A.	100.168	N.....	+0.1797	0.0	.....	.....	.....	.....	P.
		S.....	+0.1797	0.0	.....	.....	.....	.....	P.
		Mean.	+0.1797	.....	0.0	6.9	7.7500	25.427	
T. B. M. 122 to T. B. M. 123...	100.859	N.....	+0.1764	−1.6	.....	.....	.....	.....	P.
		S.....	+0.1731	+1.7	.....	.....	.....	.....	P.
		Mean.	+0.1748	.....	1.1	.....	7.7451	25.411	
T. B. M. 123 to T. B. M. 124...	103.003	N.....	+0.9976	+2.2	.....	.....	.....	.....	P.
		S.....	+1.0021	−2.3	.....	.....	.....	.....	P.
		Mean.	+0.9998	.....	1.5	.....	8.7449	28.691	
T. B. M. 124 to B. M. $2\frac{1}{2}^{a}$.....	103.073	N.....	−1.3042	−0.3	.....	.....	.....	.....	P.
		S.....	−1.3048	+0.3	.....	.....	.....	.....	P.
		Mean.	−1.3045	.....	0.2	7.2	7.4404	24.411	
T. B. M. 124 to B. M. $2\frac{1}{2}^{a}$ A...	103.073	N.....	−0.0912	+0.4	.....	.....	.....	.....	P.
		S.....	−0.0905	−0.3	.....	.....	.....	.....	P.
		Mean.	−0.0908	.....	0.2	7.2	8.6541	28.393	
T. B. M. 124 to T. B. M. 125...	103.651	N.....	−0.4243	−0.9	.....	.....	.....	.....	T.
		S.....	−0.4260	+0.8	.....	.....	.....	.....	T.
		Mean.	−0.4252	.....	0.6	.....	8.3197	27.296	
T. B. M. 125 to T. B. M. 126...	104.501	N.....	−0.5370	+1.4	.....	.....	.....	.....	T.
		S.....	−0.5340	−1.6	.....	.....	.....	.....	T.
		S.....	−0.5357	+0.1	.....	.....	.....	.....	T.
		Mean.	−0.5356	.....	0.6	.....	7.7841	25.539	
T. B. M. 126 to T. B. M. 127...	105.308	N.....	+0.3177	−1.5	.....	.....	.....	.....	T.
		S.....	+0.3137	+2.5	.....	.....	.....	.....	T.
		N.....	+0.3180	−1.8	.....	.....	.....	.....	T.
		S.....	+0.3153	+0.9	.....	.....	.....	.....	T.
		Mean.	+0.3162	.....	0.7	.....	8.1003	26.576	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 127 to P. B. M. 29....	105.352	N.....	—1.1323	0.0	.....	.....	.....	.....	T.
		S	—1.1323	0.0	.....	.....	.....	.....	T.
		Mean.	—1.1323	.....	0.0	7.2	6.9680	22.861	
T. B. M. 127 to P. B. M. 29 A.	105.352	N.....	+0.0743	0.0	.....	.....	.....	.....	T.
		S	+0.0743	0.0	.....	.....	.....	.....	T.
		Mean.	+0.0743	.....	0.0	7.2	8.1746	26.819	
T. B. M. 127 to T. B. M. 128...	106.465	N.....	—0.4297	+0.4	.....	.....	.....	.....	T.
		S	—0.4290	—0.3	.....	.....	.....	.....	T.
		Mean.	—0.4293	.....	0.2	.....	7.6710	25.168	
T. B. M. 128 to T. B. M. 129...	107.582	N.....	+0.1170	—0.2	.....	.....	.....	.....	T.
		S	+0.1167	+0.1	.....	.....	.....	.....	T.
		Mean.	+0.1168	.....	0.1	.....	7.7878	25.551	
T. B. M. 129 to B. M. $2\frac{3}{4}$.....	107.705	N.....	—0.8803	0.0	.....	.....	.....	.....	T.
		S	—0.8803	0.0	.....	.....	.....	.....	T.
		Mean.	—0.8803	.....	0.0	7.2	6.9075	22.663	
T. B. M. 129 to B. M. $2\frac{3}{4}$ A...	107.705	N.....	+0.3257	+0.4	.....	.....	.....	.....	T.
		S	+0.3265	—0.4	.....	.....	.....	.....	T.
		Mean.	+0.3261	.....	0.3	7.2	8.1139	26.621	
T. B. M. 129 to T. B. M. 130...	108.363	N.....	+0.4017	+0.1	.....	.....	.....	.....	T.
		S	+0.4019	—0.1	.....	.....	.....	.....	T.
		Mean.	+0.4018	.....	0.1	.....	8.1896	26.869	
T. B. M. 130 to T. B. M. 131...	109.915	N.....	+0.6217	+1.5	.....	.....	.....	.....	T.
		S	+0.6247	—1.5	.....	.....	.....	.....	T.
		Mean.	+0.6232	.....	1.0	.....	8.8128	28.914	
T. B. M. 131 to P. B. M. 30....	110.085	N.....	—1.5897	+0.5	.....	.....	.....	.....	P.
		S	—1.5882	—0.5	.....	.....	.....	.....	P.
		Mean.	—1.5892	.....	0.3	7.3	7.2236	23.700	
T. B. M. 131 to P. B. M. 30 A.	110.085	N.....	—0.3820	—0.5	.....	.....	.....	.....	P.
		S	—0.3830	+0.5	.....	.....	.....	.....	P.
		Mean.	—0.3825	.....	0.3	7.3	8.4303	27.659	
T. B. M. 131 to T. B. M. 132...	111.648	N.....	+0.0985	—1.7	.....	.....	.....	.....	P
		S	+0.0950	+1.8	.....	.....	.....	.....	P
		Mean.	+0.0967	.....	1.2	.....	8.0095	29.231	
T. B. M. 132 to Ⓐ Berthoud = B. M. $2\frac{3}{4}$	112.518	N.....	+0.0590	+0.1	.....	.....	.....	.....	
		S	+0.0592	—0.1	.....	.....	.....	.....	
		Mean.	+0.0591	.....	0.1	.....	8.9686	29.425	
Ⓐ Berthoud to T. B. M. 133..	113.735	N.....	+0.5510	—1.8	.....	.....	.....	.....	
		S	+0.5473	+1.9	.....	.....	.....	.....	
		Mean.	+0.5492	.....	1.2	.....	9.5178	31.227	
T. B. M. 133 to T. B. M. 134...	114.733	N.....	—0.0463	—0.5	.....	.....	.....	.....	
		S	—0.0472	+0.4	.....	.....	.....	.....	
		Mean.	—0.0468	.....	0.3	.....	9.4710	31.073	
T. B. M. 134 to T. B. M. 135...	115.615	N.....	—1.1237	+1.5	.....	.....	.....	.....	
		S	—1.1207	—1.5	.....	.....	.....	.....	
		Mean.	—1.1222	.....	1.0	.....	8.3488	27.391	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 135 to P. B. M. 31	115.770	N	−1.4337	+0.2					T.
		S	−1.4333	−0.2					T.
		Mean	−1.4335		0.1	7.6	7.9153	22.688	
T. B. M. 135 to P. B. M. 31 A	115.770	N	−0.2280	0.0					T.
		S	−0.2280	0.0					T.
		Mean	−0.2280		0.0	7.6	8.1208	26.643	
T. B. M. 135 to T. B. M. 136	116.954	N	−0.0423	−1.0					T.
		S	−0.0443	+1.0					T.
		Mean	−0.0433		0.7		8.3055	27.249	
T. B. M. 136 to T. B. M 2 3	117.102	N	−1.1837	+0.5					P.
		S	−1.1827	−0.5					P.
		Mean	−1.1832		0.3	7.6	7.1223	23.367	
T. B. M. 136 to B. M. 2 3 A	117.102	N	+0.0223	+0.5					P.
		S	+0.0233	−0.5					P.
		Mean	+0.0228		0.3	7.6	8.3283	27.324	
T. B. M. 136 to T. B. M. 137	118.416	N	+1.4551	−2.1					P.
		S	+1.4508	+2.1					P.
		Mean	+1.4530		1.4		9.7585	32.016	
T. B. M. 137 to T. B. M. 138	120.439	N	−0.5439	−0.2					P.
		S	−0.5443	+0.2					P.
		Mean	−0.5441		0.1		9.2144	30.231	
T. B. M. 138 to P. B. M. 32	120.461	N	−0.7073	+0.3					T.
		S	−0.7067	−0.3					T.
		Mean	−0.7070		0.2	7.7	8.5074	27.912	
T. B. M. 138 to P. B. M. 32 A	120.461	N	+0.5043	−0.3					T.
		S	+0.5037	+0.3					T.
		Mean	+0.5040		0.2	7.7	9.7181	31.885	
T. B. M. 138 to T. B. M. 139	121.981	N	−1.3190	0.0					T.
		S	−1.3190	0.0					T.
		Mean	−1.3190		0.0		7.8954	25.904	
T. B. M. 139 to B. M. 2 1	122.125	N	−0.2605	−0.5					P.
		S	−0.2614	+0.4					P.
		Mean	−0.2610		0.3	7.7	7.6344	25.047	
T. B. M. 139 to B. M. 2 1 A	122.125	N	+0.9457				8.8411	29.006	P.
T. B. M. 139 to T. B. M. 140	123.298	N	+0.7078	−0.9					P.
		S	+0.7096	−0.9					P.
		Mean	+0.7087		0.6		8.6041	28.229	
T. B. M. 140 to T. B. M. 141	124.265	N	+1.0569	+0.9					P.
		S	+1.0586	−0.8					P.
		Mean	+1.0578		0.6		9.6619	31.699	
T. B. M. 141 to P. B. M. 33	124.447	N	−2.1782	+0.2					T.
		S	−2.1777	−0.3					T.
		Mean	−2.1780		0.2	7.8	7.4839	24.554	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 141 to P. B. M. 33 A..	124.447	N.....	−0.9713	+0.1	.....	.....	.....	.....	T.
		S	−0.9712	0.0	.....	.....	.....	.....	T.
		Mean.	−0.9712	.....	0.0	7.8	8.6907	28.513	
T. B. M. 141 to T. B. M. 142...	125.503	N.....	+0.2025	−0.9	.....	.....	.....	.....	P.
		S	+0.2006	+1.0	.....	.....	.....	.....	P.
		Mean.	+0.2016	.....	0.6	.....	9.8635	32.361	
T. B. M. 142 to T. B. M. 143...	126.679	N.....	−0.4390	+0.6	.....	.....	.....	.....	P.
		S	−0.4379	−0.5	.....	.....	.....	.....	P.
		Mean.	−0.4384	.....	0.4	.....	9.4251	30.923	
T. B. M. 143 to B. M. 2¾	126.739	N.....	−1.1985	0.0	.....	.....	.....	.....	P.
		S	−1.1986	+0.1	.....	.....	.....	.....	P.
		Mean.	−1.1985	.....	0.0	7.8	8.2266	26.990	
T. B. M. 143 to B. M. 2½ A ...	126.739	N.....	+0.0089	−0.1	.....	.....	.....	.....	P.
		S	+0.0088	0.0	.....	.....	.....	.....	P.
		Mean.	+0.0088	.....	0.0	7.8	9.4339	30.951	
T. B. M. 143 to T. B. M. 144...	129.052	N.....	−1.3087	+2.0	.....	.....	.....	.....	P.
		S	−1.3047	−2.0	.....	.....	.....	.....	P.
		Mean.	−1.3067	.....	1.3	.....	8.1184	26.635	
T. B. M. 144 to P. B. M. 34....	129.089	N.....	−0.8960	+0.8	.....	.....	.....	.....	P.
		S	−0.8943	−0.9	.....	.....	.....	.....	P.
		Mean.	−0.8952	.....	0.6	7.9	7.2232	23.698	
T. B. M. 144 to P. B. M. 34 A..	129.089	N.....	+0.3080	+0.5	.....	.....	.....	.....	P.
		S	+0.3070	−0.5	.....	.....	.....	.....	P.
		Mean.	+0.3075	.....	0.3	7.9	8.4259	27.644	
T. B. M. 144 to T. B. M. 145...	130.178	N.....	+0.5000	+1.0	.....	.....	.....	.....	P.
		S	+0.5021	−1.1	.....	.....	.....	.....	P.
		Mean.	+0.5010	.....	0.7	.....	8.6194	28.279	
T. B. M. 145 to T. B. M. 146...	131.046	N.....	−0.5083	−1.7	.....	.....	.....	.....	P.
		S	−0.5117	+1.7	.....	.....	.....	.....	P.
		Mean.	−0.5100	.....	1.1	.....	8.1094	26.606	
T. B. M. 146 to B. M. 2½	131.174	N.....	−0.7643	−0.2	.....	.....	.....	.....	T.
		S	−0.7647	+0.2	.....	.....	.....	.....	T.
		Mean.	−0.7645	.....	0.1	8.0	7.3449	24.098	
T. B. M. 146 to B. M. 2½ A ...	131.174	N.....	+0.4393	−0.3	.....	.....	.....	.....	T.
		S	+0.4387	+0.3	.....	.....	.....	.....	T.
		Mean.	+0.4390	.....	0.2	8.0	8.5484	28.046	
T. B. M. 146 to T. B. M. 147...	132.724	N.....	−0.1717	+2.5	.....	.....	.....	.....	T.
		S	−0.1667	2.5	.....	.....	.....	.....	T.
		Mean.	−0.1692	.....	1.7	.....	7.9402	26.051	
T. B. M. 147 to T. B. M. 148...	134.527	N.....	+1.0477	+0.5	.....	.....	.....	.....	T.
		S	+1.0487	−0.5	.....	.....	.....	.....	T.
		Mean.	+1.0482	.....	0.3	.....	8.9884	29.490	
T. B. M. 148 to P. B. M. 35....	134.961	N.....	−1.7560	+0.2	.....	.....	.....	.....	T.
		S	−1.7557	−0.1	.....	.....	.....	.....	T
		Mean.	−1.7558	.....	0.1	8.2	7.2326	23.729	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
P. B. M. 35 to P. B. M. 35 A...	134.961	N....	+1.2037	—0.5					T.
		S....	+1.2027	+0.5					T.
		Mean.	+1.2032		0.3	8.2	8.4358	27.677	
T. B. M. 148 to T. B. M. 149...	135.757	N....	+0.1094	—1.0					P.
		S....	+0.1074	+1.0					P.
		Mean.	+0.1084		0.7		9.0968	29.845	
T. B. M. 149 to T. B. M. 150...	137.200	N....	—0.3678	—0.1					P.
		S....	—0.3680	+1.0					P.
		Mean.	—0.3679		0.1		8.7289	28.638	
T. B. M. 150 to B. M. 2½*...	137.394	N....	—1.5625	+0.4					P.
		S....	—1.5617	—0.4					P.
		Mean.	—1.5621		0.3	8.2	7.1668	23.513	
T. B. M. 150 to B. M. 2½* A...	137.394	N....	—0.3543	—0.6					P.
		S....	—0.3555	+0.6					P.
		Mean.	—0.3549		0.4	8.3	8.3740	27.474	
T. B. M. 150 to T. B. M. 151...	138.219	N....	+0.8119	—0.1					P.
		S....	+0.8118	0.0					P.
		Mean.	+0.8118		0.0		9.5407	31.302	
T. B. M. 151 to T. B. M. 152...	139.243	N....	—0.4455	—1.3					P.
		S....	—0.4482	+1.4					P.
		Mean.	—0.4468		0.9		9.0939	29.836	
T. B. M. 152 to P. B. M. 36....	139.529	N....	—1.6537	—0.1					T.
		S....	—1.6540	+0.2					T.
		Mean.	—1.6538		0.1	8.3	7.4401	24.410	
T. B. M. 152 to P. B. M. 36 A..	139.529	N....	—0.4510	—0.2					T.
		S....	—0.4513	+0.1					T.
		Mean.	—0.4512		0.1	8.3	8.6427	28.356	
T. B. M. 152 to T. B. M. 153...	140.555	N....	—0.5563	—0.7					T.
		S....	—0.5577	+0.7					T.
		Mean.	—0.5570		0.5		8.5369	28.008	
T. B. M. 153 to T. B. M. 154...	141.658	N....	+0.0473	+1.0					T.
		S....	+0.0493	—1.0					T.
		Mean.	+0.0483		0.7		8.5852	28.167	
T. B. M. 154 to T. B. M. 155...	142.261	N....	+0.6353	—0.3					T.
		S....	+0.6347	+0.3					T.
		Mean.	+0.6350		0.2		9.2202	30.250	
T. B. M. 155 to B. M. 2½†.....	142.300	N....	—1.4600	0.0					T.
		S....	—1.4600	0.0					T.
		Mean.	—1.4600		0.0	8.3	7.7602	25.460	
T. B. M. 155 to B. M. 2½† A....	142.300	N....	—0.2570	0.0					T.
		S....	—0.2570	0.0					T.
		Mean.	—0.2570		0.0	8.3	8.9632	29.407	
T. B. M. 155 to T B. M. 156...	143.226	N....	+0.1597	—0.2					T.
		S....	+0.1593	+0.2					T.
		Mean.	+0.1595		0.1		9.3797	30.774	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 156 to T. B. M. 157	145.044	N	−0.0150	+2.2					T.
		S	−0.0107	+2.1					T.
		Mean	−0.0128		1.4		9.3669	30.732	
T. B. M. 157 to P. B. M. 37	145.139	N	−0.7823	+0.1					T.
		S	−0.7820	−0.2					T.
		Mean	−0.7822		0.1	8.5	8.5847	28.165	
T. B. M. 157 to P. B. M. 37 A	145.139	N	+0.4170	+0.2					T.
		S	+0.4173	−0.1					T.
		Mean	+0.4172		0.1	8.5	9.7841	32.100	
T. B. M. 157 to T. B. M. 157 A	145.809	N	+0.2160	+1.5					T.
		S	+0.2190	−1.5					T.
		Mean	+0.2175		1.0		9.5844	31.445	
T. B. M. 157 A. to T. B. M. 158	146.550	N	−0.0950	+1.2					T.
		S	−0.0920	−1.8					T.
		N	−0.0957	+1.9					T.
		S	−0.0927	−1.1					T.
		Mean	−0.0938		0.6		9.4906	31.137	
T. B. M. 158 to T. B. M. 159	147.416	N	+0.0493	+0.5					T.
		S	+0.0503	−0.5					T.
		Mean	+0.0498		0.3		9.5404	31.301	
T. B. M. 159 to B. M. $\frac{21}{2}$	147.759	N	−1.1268	+0.4					P.
		S	−1.1261	−0.3					P.
		Mean	−1.1264		0.2	8.5	8.4140	27.605	
T. B. M. 159 to T. B. M. 160	148.199	N	−0.4599	+0.7					P.
		S	−0.4586	−0.6					P.
		Mean	−0.4592		0.4		9.0812	29.794	
T. B. M. 160 to T. B. M. 161	149.335	N	+0.5696	+2.0					P.
		S	+0.5737	−2.1					P.
		Mean	+0.5716		1.4		9.6528	31.670	
T. B. M. 161 to T. B. M. 162	150.457	N	+1.5484	+1.0					P.
		S	+1.5505	−1.1					P.
		Mean	+1.5494		0.7		11.2022	36.753	
T. B. M. 162 to T. B. M. 163	150.802	N	−0.8793	0.0					P.
		S	−0.8793	0.0					P.
		Mean	−0.8793		0.0		10.3229	33.868	
T. B. M. 163 to P. B. M. 38	150.912	N	−0.8032	−0.3					P.
		S	−0.8038	+0.3					P.
		Mean	−0.8035		0.2	8.7	9.5194	31.232	
T. B. M. 163 to T. B. M. 164	152.393	N	−3.0972	+0.6					P.
		S	−3.0959	−0.7					P.
		Mean	−3.0966		0.4		7.2263	23.709	
T. B. M. 164 to T. B. M. 165	153.248	N	+0.2542	−2.9					P.
		S	+0.2495	+1.8					P.
		N	+0.2504	+0.9					P.
		S	+0.2513	0.0					P.
		Mean	+0.2513		0.7		7.4776	24.533	

***Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893*—Continued.**

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench mark.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 165 to B. M. 2¼ A...	153.689	N.....	+0.2220	+0.7	.....	.....	.....	.....	P.
		S.....	+0.2234	−0.7	.....	.....	.....	.....	P.
		Mean.	+0.2227	.....	0.5	8.7	7.7003	25.264	
T. B. M. 165 to T. B. M. 166...	154.536	N.....	−0.1006	−0.1	.....	.....	.....	.....	P.
		S.....	−0.1008	+0.1	.....	.....	.....	.....	P.
		Mean.	−0.1007	.....	0.1	.....	7.3769	24.203	
T. B. M. 166 to P. B. M. 39....	155.203	N.....	+0.4083	+1.0	.....	.....	.....	.....	T.
		S.....	+0.4103	−1.0	.....	.....	.....	.....	T.
		Mean.	+0.4093	.....	0.7	8.8	7.7862	25.546	
T. B. M. 166 to T. B. M. 167...	156.025	N.....	−0.1237	+1.2	.....	.....	.....	.....	T.
		S.....	−0.1213	−1.2	.....	.....	.....	.....	T.
		Mean.	−0.1225	.....	0.8	.....	7.2544	23.801	
T. B. M. 167 to T. B. M. 168...	156.769	N.....	+0.1190	+0.2	.....	.....	.....	.....	T.
		S.....	+0.1193	−0.1	.....	.....	.....	.....	T.
		Mean.	+0.1192	.....	0.1	.....	7.3736	24.192	
T. B. M. 168 to P. B. M. 40....	156.780	N.....	+1.2562	−0.3	.....	.....	.....	.....	T.
		S.....	+1.2556	+0.3	.....	.....	.....	.....	T.
		Mean.	+1.2559	.....	0.2	8.8	8.6295	28.312	
T. B. M. 168 to T. B. M. 169...	157.983	N.....	−0.6730	+0.2	.....	.....	.....	.....	T.
		S.....	−0.6727	−0.1	.....	.....	.....	.....	T.
		Mean.	−0.6728	.....	0.1	.....	6.7008	21.984	
T. B. M. 169 to P. B. M. 41....	157.998	N.....	−0.1727	0.0	.....	.....	.....	.....	T.
		S.....	−0.1727	0.0	.....	.....	.....	.....	T.
		Mean.	−0.1727	.....	0.0	8.8	6.5281	21.418	
T. B. M. 169 to T. B. M. 171...	158.795	N.....	+0.9027	−1.3	.....	.....	.....	.....	T.
		S.....	+0.9000	+1.4	.....	.....	.....	.....	T.
		Mean.	+0.9014	.....	0.9	8.8	7.6022	24.942	
T. B. M. 171 to T. B. M. 172...	160.153	N.....	−0.3317	+0.7	.....	.....	.....	.....	T.
		S.....	−0.3303	−0.7	.....	.....	.....	.....	T.
		Mean.	−0.3310	.....	0.5	.....	7.2712	23.856	
T. B. M. 172 to P. B. M. 42....	160.201	N.....	+0.3553	−0.1	.....	.....	.....	.....	P.
		S.....	+0.3550	+0.2	.....	.....	.....	.....	P.
		Mean.	+0.3552	.....	0.1	8.8	7.6264	25.021	
T. B. M. 172 to P. B. M. 43....	162.486	N.....	+2.9362	−0.8	.....	.....	.....	.....	P.
		S.....	+2.9347	+0.7	.....	.....	.....	.....	P.
		Mean.	+2.9354	.....	0.5	8.8	10.2066	33.486	
T. B. M. 169 to T. B. M. 170...	150.095	N.....	−0.0837	−0.5	.....	.....	.....	.....	T.
		S.....	−0.0847	+0.5	.....	.....	.....	.....	T.
		Mean.	−0.0842	.....	0.3	.....	6.6166	21.708	
T. B. M. 170 to T. B. M. 175...	160.416	N.....	+0.3793	+0.5	.....	.....	.....	.....	T.
		S.....	+0.3803	−0.5	.....	.....	.....	.....	T.
		Mean.	+0.3798	.....	0.3	.....	6.9964	22.954	
T. B. M. 175 to U. S. P. B. M. 3 of 1882.....	160.816	N.....	+0.6702	−0.8	.....	.....	.....	.....	P.
		S.....	+0.6687	+0.7	.....	.....	.....	.....	P.
		Mean.	+0.6694	.....	0.5	8.8	7.6658	25.150	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
T. B. M. 175 to U. S. P. B. M. 2 of 1882	*Km.* 161.746		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
		N	+2.1633	—1.1					P.
		S	+2.1610	+1.2					P.
		Mean.	+2.1622		0.8	8.9	9.1586	30.048	
U. S. P. B. M. 2 of 1882 to B. M. City Stone "Halfway House"	164.270								
		N	—1.1700	—1.6					P.
		S	—1.1732	+1.6					P.
		Mean.	—1.1716		1.1	8.9	7.0870	26.204	

DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS BETWEEN THE HEAD OF THE PASSES AND NEW ORLEANS, LA.

NOTE.—Elevations are given in meters and feet above Cairo datum plane. To reduce to mean gulf level at Biloxi, Miss., subtract 21.26 feet (preliminary value) from the elevations here given. These bench marks were established in 1893. One meter=3.2808693 feet. The term "P. B. M." denotes a precise bench mark which is set with special care so as to be practically permanent. In most cases a P. B. M. consists of a vitrified tile 18 inches by 18 inches by 4 inches, in the center of which is set vertically with lead a ¾-inch copper bolt, the upper end being about flush with the upper surface of the tile. Surrounding the bolt on the surface of the tile is the inscription, "Mississippi River Commission, U. S. P. B. M., 1892." This is buried in the ground from 18 to 40 inches beneath the surface, the depth varying with the nature of the material. On top of the tile a 4-inch wrought-iron gas pipe 4 feet long is set concentric with the copper bolt; the lower end of the pipe, which is expanded somewhat like a boiler tube, fitting in a circular groove molded in the tile. A cast-iron cap fits over the top of the pipe and is fastened thereto with bronze bolts. The elevation of the top of the cup is also determined. The structure has thus two bench marks. P. B. M. 16, for example, being the top of the copper bolt, and P. B. M. 16 A being the top of the cap on the pipe. Other P. B. Ms. consist of copper bolts or well-defined marks in brick and stone buildings and masonry structures.

The term "T. B. M." denotes a temporary bench mark whose elevation is as well determined as that of a P. B. M., but is not regarded permanent. They consist of nails and spikes in roots of trees or stakes driven in the ground. They were established to obtain comparisons of results about once in every kilometer.

U. S. Engineers' gauge is a vertical board gauge fastened to foundation post of boat-house on west side at head of South Pass, La., and 140 meters northeastward from Head of Passes Light-House.

Elevation of zero, 5.8292 meters. 19.125 feet.

Old gauge is the remains of a vertical board gauge, standing about 100 meters from edge of water and 50 meters northwestward from the Head of Passes Light-House and about 15 meters west of fence on west side of light-house yard. No facts could be obtained relative to when this gauge was established and under whose direction it was maintained. Judging from its location and condition it has been abandoned many years.

Elevation of zero, 5.8654 meters. 19.244 feet.

Bench mark in Head of Passes Light-House is a + cut in top brick in the northeast corner of Head of Passes Light-House foundation. Is in the north end of brick farthest east and about 1 meter above ground.

Elevation, 8.1438 meters. 26.719 feet.

P. B. M. 1 is the top of copper bolt leaded vertically in a vitrified clay slab in ground and surmounted by an iron pipe. It is 1 meter from each fence in the northwest corner of the yard surrounding the Head of Passes Light-house. Is 52 meters from the northwest corner of the light-house.

Elevation, 6.5128 meters. 21.368 feet.

P. B. M. 1 A is top of cap on top of pipe over P. B. M. 1, described above.

Elevation, 7.7178 meters. 25.321 feet.

P. B. M 2. is the center of a horizontal copper bolt leaded in the west wall of the brick oil house about 20 meters east of the Head of Passes Light-House. It is in the sixteenth course of bricks above the ground and is marked thus: U. S. P. B. M. ⊙

Elevation, 8.0306 meters. 26.347 feet.

P. B. M. 3 is top of copper bolt in vitrified clay slab in ground on west bank, about 100 meters back from river, about 2,300 meters above the Head of Passes Light-House;

is S. 60° W. 84 meters from △ Donovan No. 2. It is $5\frac{5}{10}$ meters from a 14-inch blazed willow tree.

Elevation, 6.7035 meters. 21.993 feet.

P. B. M. 3 A is top of cap on top of pipe over P. B. M. 3, described above.

Elevation, 7.9025 meters. 25.927 feet.

T. B. M. 5 is a spike in east root of a 14-inch willow tree, $5\frac{5}{10}$ meters from P. B. M. 3.

Elevation, 6.9589 meters. 22.831 feet.

B. M. $2\frac{5}{4}$ is top of copper bolt in vitrified clay slab in ground; is on west bank, just opposite Pilot tower and 30 meters from river. Azimuths and distances from the B. M. are: To Pilots' tower, 243° 23′ 11″—1,491.63 meters; to Ⓐ Cubitt's chimney, 297° 25′ 04″—2,931.28 meters; to Ⓐ north, 179° 17′ 11″—2,939.63 meters; to Fog-bell tower, 192° 51′ 40″.

Elevation, —— meters. —— feet.

B. M. $2\frac{5}{4}$ A is top of cap on top of pipe over B. M. $2\frac{5}{4}$, described above.

Elevation, 7.3951 meters. 24.262 feet.

T. B. M. 8 is nail in a four-pronged willow tree, 8 meters from B. M. $2\frac{5}{4}$.

Elevation, 7.2083 meters. 23.650 feet.

P. B. M. 4 is top of copper bolt in vitrified clay slab in ground on west bank about opposite middle of Cubitts Crevasse and 50 meters back from river. There is a 12-inch willow 3½ meters northwest of the B. M. and another 12-inch willow 12 meters northwest which contains T. B. M. 11.

Elevation, 6.7787 meters. 22.240 feet.

P. B. M. 4 A is top of cap on top of pipe over P. B. M. 4, described above.

Elevation, 7.9807 meters. 26.184 feet.

T. B. M. 11 is nail in root of a 12-inch willow tree 12 meters southeast of P. B. M. 4, described above.

Elevation, 7.1859 meters. 23.576 feet.

T. B. M. 14 is nail in east root of a 24-inch willow tree south 50° west; 30 meters from B. M. $2\frac{1}{2}$.

Elevation, 7.3241 meters. 24.029 feet.

T. B. M. 5 is top of copper bolt in vitrified clay slab in ground on west bank. Is in F. L. Streckerts' orange grove and is 17 meters northward from Streckerts' house and midway between two orange trees. Is about 4 miles below the jump.

Elevation, 6.7491 meters. 22.143 feet.

P. B. M. 5 A is top of cap on top of pipe over P. B. M. 5, described above.

Elevation, 7.9578 meters. 26.108 feet.

T. B. M. 17 is nail in 12 inch willow tree about 6 meters from P. B. M. 5.

Elevation, 7.5625 meters. 24.812 feet.

P. B. M. 6 is top of copper bolt in vitrified clay slab in ground on west bank about 2,500 meters below the jump. Is 18 meters from the river in an open field. Azimuth to tower at the jump, 130° 38′ 21″.

Elevation, 6.5633 meters. 21.533 feet.

P. B. M. 6 A is top of cap on top of pipe over P. B. M. 6, described above.

Elevation, 7.7701 meters. 25,493 feet.

T. B. M. 22 is nail in root of 18-inch willow tree, 47 meters from P. B. M. 6.

Elevation, 7.4997 meters. 24,606 feet.

T. B. M. 24 is a spike in east side of the middle one of three willows 24 inches in diameter and 17 meters south of the old United States custom-house at the Jump.

Elevation, 7.7383 meters. 25,388 feet.

B. M. $2\frac{1}{2}$ is top of copper bolt in vitrified-clay slab in ground on west bank, about 100 meters above the Jump, 53 meters from the Tropical Fruit Company's store and 45 meters from Levy's store. It is respectively 16 and 13 meters from two blazed willow trees. To B. M. $2\frac{1}{2}$ 221° 46′ 56″; 1,059.06 meters. To tower at Jump, 312° 12′ 00″.

Elevation, 7.0386 meters. 23,093 feet.

B. M. $2\frac{1}{2}$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}$, described above.

Elevation, 8.2435 meters. 27,046 feet.

P. B. M. 7 is top of copper bolt in vitrified-clay slab in ground on west bank about 2,200 meters above the Jump and on land of Pierre Leon Buras. It is 7 meters back of levee, 40 meters from river, and 17 meters towards river from Buras' house.

Elevation, 6.7020 meters. 21,988 feet.

P. B. M. 7 A is top of cap on top of pipe over P. B. M. 7, described above.

Elevation, 7.9047 meters. 25,934 feet.

T. B. M. 28 is nail in east root of a 24-inch sycamore tree, 13 meters from river and about 28 meters east of a graveyard and 2½ miles above the Jump.

Elevation, 7.4222 meters. 24,351 feet.

P. B. M. 8 is top of copper bolt in vitrified-clay slab in ground on west bank on Dr. Talbots land. Is on southern slope of levee, and is 20 meters south of an 18-inch tree, blazed. Is 947 meters above house now occupied by Pierre A. Jauntures. It is about 5 miles above the Jump.

Elevation, 6.9572 meters. 22.826 feet.

P. B. M. 8 A is top of cap on top of pipe, over P. B. M. 8, described above.

Elevation, 8.1620 meters. 26.778 feet.

T. B. M. 31 is spike in north root of an 18-inch willow tree 7 meters from levee, marked with a triangular blaze, and 17 meters above P. B. M. 8.

Elevation, 7.3930 meters. 24.255 feet.

B. M. $\frac{2}{3}^{2}$ is top of copper bolt in vitrified-clay slab in ground on west bank, 33 meters back of levee, 13 meters below wire fence around orange grove. Is 10 meters from an 8-inch tree and 5 meters from a 10-inch hackberry tree, both blazed, and is about 2¼ miles below Fort Jackson.

Elevation, 6.7852 meters. 22.261 feet.

B. M. $\frac{2}{3}^{2}$ A is top of cap on top of pipe. over B. M $\frac{2}{3}^{2}$, described above.

Elevation, 7.9834 meters. 26.192 feet.

P. B. M. 9 is top of copper bolt in vitrified-clay slab in ground on S. Shoenberger's land on west bank, about 1¼ miles below Fort Jackson. It is $6\frac{7}{10}$ meters from the upper boundary of Shoenberger's land and 6 meters back of levee. Is 2 meters from an orange tree, and is 54 meters from Shoenberger's house.

Elevation, 6.9381 meters. 22.763 feet.

P. B. M. 9 A is top of cap on top of pipe over P. M. 9, described above.

Elevation, 8.1421 meters. 26.713 feet.

T. B. M. 58 is nail in crotch of 12-inch sycamore about 5 meters in front of levee, about 12 meters from P. B. M. 9.

Elevation, 8.0700 meters. 26.477 feet.

P. B. M. 10 is a vertical copper bolt in the granite block forming the bridge seat at the west abutment of the bridge crossing the moat at Fort Jackson. It is 3 inches from the lower flange of the iron stringer of the bridge, and is marked thus: $\frac{\text{U. S.}}{\text{P. B. M}}$

Elevation, 7.5385 meters. 24.733 feet.

Fort Jackson gauge is a vertical post gauge about 50 meters above the old hospital building at Fort Jackson.

Elevation of zero, 5.8700 meters. 19.258 feet.

B. M. "A" is upper surface of ship spike driven horizontally in brick chimney at upper or west end of building known as Ordnance Sergeant's dwelling. Is in west face of chimney, about 10 inches above the ground, and in second course below the weather boarding. A × is cut in brick just under the spike.

Elevation, 7.8475 meters. 25.747 feet.

T. B. M. 61 is spike in south root of 12-inch willow on old levee between new levee and river and about 400 meters above Fort Jackson.

Elevation, 7.7107 meters. 25.298 feet.

Experimental B. M. is top of copper bolt in vitrified clay slab in ground about 100 meters above Fort Jackson and 35 meters back of the levee. There is a 2-inch by 9-inch scantling set over the B. M. and projects about 18 inches above the ground.

Elevation, 6.6444 meters. 21.799 feet.

B. M. $\frac{2}{3}^{9}$ is top of copper bolt in vitrified-clay slab in ground on east bank. Is in the bend of levee surrounding Fort St. Philip military reservation and is about 100 meters below the fort. Is 109 meters from the river. To monument southeast corner of reservation 321° 06′ 45″—50.42 meters. To flag staff Fort St. Philip 69° 05′ 10″—350.4 meters.

Elevation, 7.1520 meters. 23.465 feet.

P. B. M. 11 is on top of monument marking the southeast corner of the United States reservation at Fort St. Phillip. The B. M. is the point in the obtuse angle at the intersection of the two grooves cut on the surface of the stone. The monument bears the inscription:

Elevation, 7.8718 meters. 25.826 feet.

P. B. M. 12 is a horizontal copper bolt in the granite facing of the portal on right-hand side of powder magazine No. 5, at Fort St. Philip. Is 43 inches above the concrete paving at the entrance of magazine.

Elevation, 8.2399 meters. 27.034 feet.

P. B. M. 13 is top of copper bolt in vitrified-clay slab in ground on east bank. Is on end of old levee running back to swamp on land of Patrick Callahan 1 mile above Fort St. Philip. It is 40 meters from Callahan's house and 49 meters from an old stable on the river side of main levee. Is about 6 meters inside of main levee and 70 meters from the river. To ⓐ Taylor 33° 06′ 18″. 1248.14 meters.

Elevation, 7.3498 meters. 24.114 feet.

P. B. M. 13 A is top of cap on top of pipe over P. B. M. 13, described above.

Elevation, 8.5601 meters. 28.085 feet.

T. B. M. 65 is nail in 18-inch willow tree on river side of levee in front of Patrick Callahan's house, and is about 10 meters from P. B. M. 13.

Elevation, 7.4738 meters. 24.521 feet.

B. M. $2\frac{A}{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank. Is 10 meters back of levee, 25 meters from river, and 20 meters above Mrs. S. H. Butler's store and Neptune post-office. It is about $2\frac{1}{4}$ miles above Fort St. Philip.

Elevation, 6.9510 meters. 22.805 feet.

B. M. $2\frac{A}{2}$ A is top of cap on top of pipe over B. M. $2\frac{A}{2}$, described above.

Elevation, 8.1554 meters. 26.757 feet.

T. B. M. 68 is nail in north side of 18-inch willow in center of levee, 38 meters west of Mrs. Butler's store, and within 20 meters of B. M. $2\frac{A}{2}$, described above.

Elevation, 8.2952 meters. 27.215 feet.

P. B. M. 14 is top of copper bolt in vitrified-clay slab in ground on east bank on land of Marie Antoinette Grandpré Smith. It is 70 feet southwest of Mrs. Smith's house, and 3 feet inside of road fence, and 12 feet from a line stake between Mrs. Smith's and Herman Beck's lands and about $3\frac{1}{4}$ miles above Fort St. Philip.

Elevation, 6.7551 meters. 22.163 feet.

P. B. M. 14 A is top of cap on top of pipe over P. B. M. 14, described above.

Elevation, 7.9597 meters. 26.115 feet.

T. B. M. 70 is nail in east root of 12-inch red elm on east side of levee on line between lands of Mrs. Smith and Mrs. Brophie, and within 80 meters of P. B. M. 14.

Elevation, 7.5684 meters. 24.831 feet.

P. B. M. 15 is top of vertical copper bolt in west end of second door sill from east end of the old United States customs and quarantine building, about 5 miles above Fort St. Phillip.

Elevation, 8.0318 meters. 26.351 feet.

B. M. $2\frac{I}{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of August Barry about 1 mile above the old United States customs and quarantine buildings. It is 15 meters southeast of Barry's house and 10 meters back of levee, and 140 meters from the river. To Buras Church, 324° 46′ 35″, 1,368.7 meters; to B. M. $2\frac{I}{2}$, 18° 02′ 12″, 897.9 meters.

Elevation, 6.9098 meters. 22.670 feet.

B. M. $2\frac{I}{2}$ A is top of cap on top of pipe over B. M. $2\frac{I}{2}$, described above.

Elevation, 8.1125 meters. 26.616 feet.

T. B. M. 73 is nail in root of 20-inch willow tree in line of fence along road about 1 mile above old United States customs and quarantine buildings, and about 60 meters below B. M. $2\frac{I}{2}$.

Elevation, 7.4196 meters. 24.343 feet.

P. B. M. 16 is top of copper bolt in vitrified-clay slab in ground on east bank on land of Antoine Jones, about $2\frac{1}{4}$ miles above the old United States customs and quarantine buildings. It is 43 meters from Jones's house, and 52 meters from schoolhouse; is 5 meters back of levee, and 7 feet from a post marking the line between lands of Antoine Jones and Gilbert Buras. To ⓐ Grand Prairie, 149° 24′ 56″, 116.27 meters.

Elevation, 6.9338 meters. 22.749 feet.

P. B. M. 16 A is top of cap on top of pipe over P. B. M. 16, described above.

Elevation, 8.1402 meters. 26.707 feet.

B. M. $2\frac{S}{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of V. Loceco. Is 6 meters back of the levee and 18 meters from Loceco's house, and 430 meters below negro school and church, and about 750 meters below O. K. red store.

Elevation, 6.7210 meters. 22.051 feet.

B. M. $2\frac{A}{2}$ A is top of cap on top of pipe over B. M. $2\frac{S}{2}$ described above.

Elevation, 7.9266 meters. 26.006 feet.

P. B. M. 17 is top of copper bolt in vitrified-clay slab in ground on east bank. Is in the southwest corner of Noel Buras' orange grove, 1 meter from each fence. Is 90 meters west of a schoolhouse, and about $5\frac{1}{4}$ miles above the old United States customs and quarantine buildings.

Elevation, 6.6439 meters. 21.798 feet.

P. B. M. 17 A is top of cap on top of pipe over P. B. M. 17, described above.

Elevation, 7.8513 meters. 25.759 feet.

T. B. M. 78 is nail in root of 10-inch willow, just outside of levee, about 100 meters below bend in levee, and about 13 meters from P. B. M. 17.

Elevation, 7.7793 meters. 25.523 feet.

B. M. $2\frac{5}{8}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Meyer Wise, 15 meters back of road, and about 50 meters above fence corner, and about 195 meters above John Kelley's house and about 290 meters below Hicks Bayou.

Elevation, 6.8290 meters. 22.405 feet.

B. M. $2\frac{5}{8}$ A is top of cap on top of pipe over B. M. $2\frac{5}{8}$ described above.

Elevation, 8.0390 meters. 26.375 feet.

P. B. M. 18 is top of copper bolt in vitrified-clay slab in ground on east bank, 4 meters in front of J. Liugoni's house, about 80 meters back of levee and 20 meters from Harris' Canal.

Elevation, 6.6926 meters. 21.958 feet.

P. B. M. 18 A is top of cap on top of pipe over P. B. M. 18, described above.

Elevation, 7.9014 meters. 25.923 feet.

B. M. $2\frac{3}{4}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Berkson Brothers. Is about 18 meters back of point where old and new levees unite. Is 17 meters below a house. Is 105 meters from the river, and 60 meters northwest of a 3-foot hackberry, blazed, which stands outside the levee. To church spire, 119° 03′ 18″, 141.21 meters.

Elevation, 6.9555 meters. 22.820 feet.

B. M. $2\frac{3}{4}$ A is top of cap on top of pipe over B. M. $2\frac{3}{4}$ described above.

Elevation, 8.1669 meters. 26.795 feet.

T. B. M. 84 is nail in root of 24-inch hackberry tree, outside of levee, and 60 meters from B. M. $2\frac{3}{4}$.

Elevation, 8.1167 meters. 26.630 feet.

△ White is a U. S. Coast Survey station and is about 1,160 meters above Wesley church and 110 meters from the road on river side. It is an iron screw pile projecting above ground, the top terminating in a cast-iron cap bearing the inscription "U. S. Coast Survey, 1870, G + P." The bench mark is the highest point of the letter C.

Elevation. 8.1307 meters. 26.676 feet.

P. B. M. 19 is top of copper bolt in vitrified-clay slab in ground on east bank on land of William Laudebaugh. Is 1 meter north of a 36-inch hackberry tree, blazed. Is 30 meters north of Laudebaugh's house and 66 meters from levee and about $1\frac{1}{2}$ miles above Wesley church.

Elevation, 7.6220 meters. 25.007 feet.

P. B. M. 19 A is top of cap on top of pipe over P. B. M. 19, described above.

Elevation, 8.8310 meters. 28.973 feet.

T. B. M. 86 is nail in north root of 30-inch hackberry tree on south side of road and is 37 meters from P. B. M. 19.

Elevation, 7.8310 meters. 25.692 feet.

T. B. M. 88 is nail in root of 20-inch live oak 150 meters south of school house and 1,800 meters below Nestor landing.

Elevation, 8.3353 meters, 27.347 feet.

P. B. M. 20 is top of copper bolt in vitrified-clay slab in ground 15 meters back of levee and $4\frac{8}{10}$ meters north of the northwest corner of S. M. Fusich & Co.'s store, at Nestor Landing. It is 32 meters south of the center of Nestor Canal.

Elevation, 7.0535 meters. 23.142 feet.

P. B. M. 20 A is top of cap on top of pipe over P. B. M. 20, described above.

Elevation, 8.2565 meters. 27.088 feet.

T. B. M. 91 is nail in root of 36-inch live-oak tree 5 meters east of levee and about one-half mile above Nestor Canal.

Elevation, 8.0984 meters. 26.570 feet.

B. M. $2\frac{3}{4}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Mrs. Cannon. It is 118 meters above her house, 1 meter below fence running back from road behind levee; is 12 meters from the south corner of E. J. Cannon's house and 55 meters back from levee. It is 4 feet north of a fig tree. To B. M. $2\frac{1}{4}$ 48° 27′. 816.59 meters. To Rigaud's chimney, 45° 23′ 35″.

Elevation, 6.8287 meters. 22.404 feet.

B. M. $2\frac{3}{4}$ A is top of cap on top of pipe over B. M. $2\frac{3}{4}$ A, described above.

Elevation, 8.0337 meters. 26.358 feet.

P. B. M. 21 is top of copper bolt in vitrified-clay slab in ground on east bank on Pierre Cossé's land, 6 meters back from road fence and 1 foot south of the division fence between lands of Cossé and Henry W. Fox, and about 1,000 meters below the white Episcopal Church. To △ Union, 147° 00′ 19″, 504.22 meters; to church roof apex, 150° 52′ 42″.

Elevation, 6.9837 meters. 22.913 feet.

P. B. M. 21 A is top of cap on top of pipe over P. B. M. 21, described above.
Elevation, 8.1895 meters. 26.869 feet.

Union is a U. S. Coast Survey station; is in an old orange grove 63 meters back from road and about 600 meters below the white Episcopal church. Is an iron screw pile projecting about 9 inches above the ground, terminating in a cast-iron cap bearing the inscription U. S. Coast Survey 1870 G+P. The bench mark is the + near center.
Elevation, 7.8411 meters. 25.726 feet.

T. B. M. 95 is nail in root of 30-inch willow on river side of levee, near foot of slope and about 30 meters from the white Episcopal church.
Elevation, 8.2678 meters. 27.126 feet.

B. M. $2\frac{1}{2}^{L}$ is top of copper bolt in vitrified-clay slab in ground on east bank, on line between lands of William Cannon and George Wilson. It is 23 meters back of the new levee and 119 meters from the river bank and 165 meters westward from George Wilson's house. To St. Patrick's church, 323° 09′ 31″; to gable of red house, 295° 35′ 20″.
Elevation, 6.8962 meters. 22.626 feet.

B. M. $2\frac{1}{2}^{L}$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^{L}$, described above.
Elevation, 8.1014 meters. 26.580 feet.

P. B. M. 22 is top of copper bolt in vitrified-clay slab in ground on east bank on Dr. Herbert's land, 145 meters south of his north line, and on south side of ditch. Is 188 meters from the N. O. & S. Railway and 20 meters east of the levee, and about 1,300 meters above the railway water tank at Bohemia. To tower, 112° 02′ 45″.
Elevation, 7.4535 meters. 24.454 feet.

P. B. M. 22 A is top of cap on top of pipe over P. B. M. 22, described above.
Elevation, 8.6631 meters. 28.422 feet.

B. M. $2\frac{1}{2}^{Q}$ is top of copper bolt in vitrified-clay slab in ground on east bank on north side of plantation road running along north side of Martin Brothers' plantation. Is 22 meters back of levee and about 2 miles below the Plaquemine Parish court-house.
Elevation, 6.8636 meters. 22.519 feet.

B. M. $2\frac{1}{2}^{Q}$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^{Q}$, described above.
Elevation, 8.0723 meters. 26.484 feet.

P. B. M. 23 is top of copper bolt in vitrified-clay slab in ground on east bank in Theophile Hingle's front yard, 6 meters southeast of house, 25 meters below storehouse, and 25 meters back of levee, and about 1 mile below Plaquemine Parish courthouse. To Magnolia sugarhouse, 0° 27′ 41″; to tower, 359° 14′ 31″; to tank, 354° 49′ 45″.
Elevation, 7.0461 meters. 23.117 feet.

P. B. M. 23 A is top of cap on top of pipe over P. B. M. 23, described above.
Elevation, 8.2569 meters. 27.090 feet.

T. B. M. 105 is nail in 20-inch sycamore on river side of levee about 50 meters from Baner's store and 1,400 meters above the Plaquemine Parish court-house.
Elevation, 8.3900 meters. 27.526 feet.

B. M. $2\frac{1}{2}^{P}$ is top of copper bolt in vitrified-clay slab in ground on east bank between lands of John Lafitte and B. Savois, 13 meters back of the levee, 1 meter north of row of large willows, and in fence corner. Is 375 meters above St. Thomas's church.
Elevation, 7.0592 meters. 23.160 feet.

B. M. $2\frac{1}{2}^{P}$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^{P}$, described above.
Elevation, 8.2645 meters. 27.115 feet.

P. B. M. 24 is top of vertical copper bolt in top of coping on lower side of steps leading to main entrance of the Plaquemine Parish court-house, at Pointe à la Hache. The top of the bolt is 8 millimeters below the concrete coating.
Elevation, 9.4711 meters. 31.073 feet.

P. B. M. 25 is top of copper bolt in vitrified-clay slab in ground on east bank on Mrs. Auguste Gravolet's land, about 3 miles above Plaquemine Parish court-house. Is 3 meters from a 24-inch hackberry, and 163 feet northward from the north corner of Mrs. Gravolet's house, and 111 meters from the N. O. and S. Railway.
Elevation, 6.9384 meters. 22.764 feet.

P. B. M. 25 A is top of cap on top of pipe over P. B. M. 25, described above.
Elevation, 8.1460 meters. 26.726 feet.

B. M. $2\frac{1}{2}^{S}$ is top of copper bolt in vitrified-clay slab in ground between lands of Dr. Herbert and J. Dole. Is at end of lane leading back from main road and about 2 feet from fence corner on upper side of lane, and about $4\frac{1}{2}$ miles above Plaquemine Parish court-house. To Celeste chimney, 321° 23′ 37″, 1,841.6 meters; to Junior chimney, 49° 53′ 42″, 1,286.1 meters.
Elevation, 7.2885 meters. 23.913 feet.

B. M. $2\frac{1}{2}^{S}$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^{S}$, described above.
Elevation, 8.4983 meters. 27.882 feet.

P. B. M. 26 is top of copper bolt in vitrified-clay slab in ground on east bank. Is on Bellevue Plantation, and 24 meters back of levee and 1 meter east of ditch, and

192$\frac{4}{10}$ meters from N. O. & S. Railway. To Bellevue S. H. Chimney, 111° 11′ 13″, 559.8 meters.

Elevation, 7.3817 meters. 24.218 feet.

P. B. M. 26 A is top of cap on top of pipe over P. B. M. 26, described above.

Elevation, 8.5922 meters. 28.190 feet.

T. B. M. 114 is a spike in west root of 36-inch live oak, on west edge of live-oak grove. Is 5 meters back of pasture fence and 15 meters back of levee, and 365 meters above the old sugarhouse at Harlem plantation. This bench mark was established by the levee engineers.

Elevation, 8.1310 meters. 26.677 feet.

B. M. $\frac{2}{7}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Harlem plantation, on south side of ditch running along north side of live-oak grove; is 365 meters above the old Harlem sugarhouse and 141 meters from the N. O. and S. Railway. Two live-oak trees blazed are respectively 19 and 22 meters from the bench mark. To Bellevue chimney, 299° 35′ 02″; 1,479.2 meters.

Elevation, 7.0442 meters. 23.111 feet.

B. M. $\frac{2}{7}$ A is top of cap on top of pipe over B. M. $\frac{2}{7}$, described above.

Elevation, 8.2555 meters. 27.085 feet.

P. B. M. 27 is top of copper bolt in vitrified-clay slab in ground on east bank on land of E. H. McCaleb, about 1$\frac{1}{2}$ miles above Harlem sugarhouse. It is 75 meters back of levee; is 72 meters northward from Joshua Griffin's house and in corner of small field beside ditch. To Wilkinson's sugarhouse, 94° 09′ 31″.

Elevation, 7.2796 meters. 23.883 feet.

P. B. M. 27 A is top of cap on top of pipe over P. B. M. 27, described above.

Elevation, 8.4876 meters. 27.847 feet.

T. B. M. 120 is nail in root of 14-inch willow in front yard and about 30 meters from Leopold's store and about 2$\frac{1}{2}$ miles above Harlem sugarhouse.

Elevation, 8.0162 meters. 26.300 feet.

B. M. $\frac{2}{6}$ is top of copper bolt in vitrified-clay slab in ground on east bank just below Poverty Point, 14 meters back of base of levee on C. W. Johnson's land; is 304.5 meters in front of N. O. and S. Ry., in fence corner on lower side of ditch; is 99 meters below a 14-inch live-oak tree in line of road fence. Tree is near two small houses. To Wilkinson's sugarhouse, 22° 35′ 48″; to St. Joseph's Church, 284° 8′ 45″; to St. John's Church, 273° 6′ 20″.

Elevation, 7.6512 meters. 25.103 feet.

B. M. $\frac{2}{6}$ A is top of cap on top of pipe over B. M. $\frac{2}{6}$, described above.

Elevation, 8.8557 meters. 29.054 feet.

T. B. M. 122 is a boat spike in root of 36-inch live oak, about 70 meters from main dwelling at Mon Secour's plantation. This B. M. was established by the levee engineers.

Elevation, 7.5703 meters. 24.837 feet.

P. B. M. 28 is top of copper bolt in vitrified-clay slab in ground on east bank on Mon Secour's plantation; is 7 feet east of ditch along road and 53 meters from west corner of main dwelling and 67 meters from the northwest corner of a long dwelling near road leading back to sugarhouse. To union sugarhouse, 188° 15′ 35″.

Elevation, 6.5423 meters. 21.464 feet.

P. B. M. 28 A is top of cap on top of pipe over P. B. M., described above.

Elevation, 7.7500 meters. 25.427 feet.

T. B. M. 124 is nail in root of 5-foot live oak in cane field, about 25 meters from levee and 186 meters above St. Sophia post-office. This B. M. was probably established by levee engineers.

Elevation, 8.7449 meters. 28.691 feet.

B. M. $\frac{2}{5}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Monticello plantation; is 15 meters from base of levee on lower side of plantation road at its intersection with main road, and is 144 meters above St. Sophia post-office.

Elevation, 7.4404 meters. 24.411 feet.

B. M. $\frac{2}{5}$ A is top of cap on top of pipe over B. M. $\frac{2}{5}$, described above.

Elevation, 8.6541 meters. 28.393 feet.

P. B. M. 29 is top of copper bolt in vitrified-clay slab in ground on east bank on Fairview plantation, in northwest corner of garden, in front of manager's house; is 20 meters from house and 57 meters back from levee.

Elevation, 6.9680 meters. 22.861 feet.

P. B. M. 29 A is top of cap on top of pipe over P. B. M. 29, described above.

Elevation, 8.1746 meters. 26.819 feet.

B. M. $\frac{2}{4}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Belair plantation, in negro churchyard, 17 meters from the southwest corner of the church.

Elevation, 6.9075 meters. 22.663 feet.

B. M. $\frac{2}{3}^{4}$ A is top of cap on top of pipe over B. M. $\frac{2}{3}^{4}$, described above.
Elevation, 8.1139 meters. 26.621 feet.
T. B. M. 131 is nail in root of 5-foot live oak between levee and road and about 600 meters below the main buildings at Fanny plantation.
Elevation, 8.8128 meters. 28.914 feet.
P. B. M. 30 is top of copper bolt in vitrified-clay slab in ground on east bank on Fanny plantation, about 600 meters below the main buildings, in a graveyard; is 6 feet north of ditch, 38 feet towards river from a large live-oak tree, and 245 feet from the N. O. and S. Railway, and about 160 meters back from the levee measured along ditch. To Belair sugarhouse, 330° 59′ 08″; to Fanny sugarhouse, 161° 16′ 16″.
Elevation, 7.2236 meters. 23.700 feet.
P. B. M. 30 A is top of cap on top of pipe over P. B. M. 30, described above.
Elevation, 8.4303 meters. 27.659 feet.
Ⓑ Berthoud is a U. S. Coast and Geodetic Survey station, and is B. M. $\frac{2}{3}^{3}$; is an iron-screw pile projecting about 1 foot above ground; is on the east bank on the old Woodland plantation, 10 meters in front of old levee and 101 meters back from new levee; is 8 meters above ditch and 232 meters from the New Orleans and Savannah Railway, on land of Charles Reggio. The cap on top the iron post bears the inscription "U. S. Coast and Geodetic Survey 1871, G+P." The bench mark is the + in center of cap. To Jesuit Church, 80° 03′ 48″; 894.0 meters.
Elevation, 8.9686 meters. 29.425 feet.
P. B. M. 31 is top of copper bolt in vitrified-clay slab in ground on east bank on Greenwood plantation; is in the northeast corner of a lot 110 meters above the manager's dwelling and 77 meters east of the N. O. and S. Railway.
Elevation, 6.9153 meters. 22.688 feet.
P. B. M. 31 A is top of cap on top of pipe over P. B. M. 31, described above.
Elevation, 8.1208 meters. 26.643 feet.
T. B. M. 136 is nail in root of 5-foot live oak about 25 meters back of levee and about 400 meters below the sugarhouse on Promised Land plantation. The bench mark is about 15 feet towards the river from the tree.
Elevation, 8.3055 meters. 27.249 feet.
B. M. $\frac{2}{3}^{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Linwood plantation; is 12 meters east of the N. O. and S. Railway on lower side of ditch and 4 meters above road running back to woods and about 100 meters from the main dwelling on the plantation.
Elevation, 7.1223 meters. 23.367 feet.
B. M. $\frac{2}{3}^{2}$ A is top of cap on top of pipe over B. M. $\frac{2}{3}^{2}$, described above.
Elevation, 8.3283 meters. 27.324 feet.
T. B. M. 137 is nail in fork of 24-inch willow between levee and river, about 200 meters above Gould's store. Bench mark is about 2 feet above ground.
Elevation, 9.7585 meters. 32.016 feet.
P. B. M. 32 is top of copper bolt in vitrified-clay slab in ground on east bank on Stella plantation; is in southwest corner of William Homer's front yard and 37 meters north of plantation store and about 50 meters from river.
Elevation, 8.5074 meters. 27.912 feet.
P. B. M. 32 A is top of cap on top of pipe over P. B. M. 32, described above.
Elevation, 9.7184 meters. 31.885 feet.
B. M. $\frac{2}{3}^{1}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Scarsdale plantation, on the upper edge of second ditch above Stella plantation and at intersection with ditch running parallel to river. It is 47 meters above plantation line and 153 meters from the N. O. and S. Ry.
Elevation, 7.6344 meters. 25.044 feet.
B. M. $\frac{2}{3}^{1}$ A is top of cap on top of pipe over B. M. $\frac{2}{3}^{1}$, described above.
Elevation, 8.8411 meters. 29.006 feet.
P. B. M. 33 is top of copper bolt in vitrified-clay slab in ground on east bank on Mon Plaisir plantation, about 14 meters above the north line of Scarsdale plantation; is 184 meters back from the levee and 132 meters from the N. O. and S. Ry. and 145 meters from a house back of the railway. It is on edge of ditch at junction of two plantation roads.
Elevation, 7.4839 meters. 24.554 feet.
P. B. M. 33 A is top of cap on top of pipe over P. B. M. 33 described above.
Elevation, 8.6907 meters. 28.513 feet.
P. B. M. $\frac{2}{3}^{0}$ is top of copper bolt in vitrified-clay slab in ground on east bank on St. Clair plantation 1 meter east of fence along road, 430 meters from N. O. and S. Ry., and about 390 meters above St. Clair sugarhouse chimney. To Orange Grove lightning rod, 274° 23′ 50″; to St. Clair sugarhouse, 358° 34′ 20″; to Belle Chasse sugarhouse, 42° 34′ 32″.
Elevation, 8.2266 meters. 26.990 feet.
B. M. $\frac{2}{3}^{0}$ A is top of cap on top of pipe over B. M. $\frac{2}{3}^{0}$, described above.
Elevation, 9.4339 meters. 30.951 feet.

P. B. M. 34 is top of copper bolt in vitrified-clay slab in ground on east bank on Orange Grove plantation; is in the northwest corner of intersection of two plantation roads and between road and ditch, and is 137 meters back from base of levee measured along plantation road. To Orange Grove sugarhouse cupola, 295° 11′ 51″ — 751.5 meters.

Elevation, 7.2232 meters. 23.698 feet.

P. B. M. 34 A is top of cap on top of pipe over P. B. M. 34, described above.

Elevation, 8.4259 meters. 27.644 feet.

B. M. $2\frac{1}{2}^2$ is top of copper bolt in vitrified-clay slab in ground on east bank on Orange Grove plantation; is in the northeast corner, where plantation road and ditch intersects; is 267 meters from N. O. and S. Railway and 132 meters back of levee. To Orange Grove sugarhouse cupola, 110° 38′ 22″ — 932.5 meters.

Elevation, 7.3449 meters. 24.098 feet.

B. M. $2\frac{1}{2}^2$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^2$, described above.

Elevation, 8.5484 meters. 28.046 feet.

P. B. M. 35 is top of copper bolt in vitrified-clay slab in ground on east bank on Poydras Hall plantation; is 144 meters back of the N. O. and S. Railway, at a point 90 meters above the three-throw switch at Poydras Hall junction; it is 8 meters west of the northwest corner of fence surrounding the plantation quarters.

Elevation, 7.2326 meters. 23.729 feet.

P. B. M. 35 A is top of cap on top of pipe over P. B. M. 35, described above.

Elevation, 8.4358 meters. 27.677 feet.

B. M. $2\frac{1}{2}^2$ is top of copper bolt in vitrified-clay slab in ground on east bank on the old Repose plantation; is in the southwest corner of a pasture 10 meters back from the N. O. and S. Railway; is on upper side of ditch running along lower side of plantation; is 197 meters back of levee and just back of plantation quarters. Tile-works chimney, 165° 41′ 34″.

Elevation, 7.1668 meters. 23.513 feet.

B. M. $2\frac{1}{2}^2$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^2$, described above.

Elevation, 8.3740 meters. 27.474 feet.

T. B. M. 151 is nail in root of 4-foot pecan tree, about 25 meters from negro church and 400 meters above the mouth of Lake Borgne Canal.

Elevation, 9.5407 meters. 31.302 feet.

P. B. M. 36 is top of copper bolt in vitrified-clay slab in ground on east bank on the Stoney plantation 4 meters above ditch running back from levee and 1 meter from ditch running parallel with railway; is 243 meters back of N. O. and S. Railway and about 290 meters below two small negro churches. To Stoney sugarhouse chimney, 152° 37′ 50″.

Elevation, 7.4401 meters. 24.410 feet.

P. B. M. 36 A is top of cap on top of pipe over P. B. M. 36, described above.

Elevation, 8.6427 meters. 28.356 feet.

T. B. M. 154 is nail in west root of 36-inch live oak 125 meters above section house, 6 meters below railway and wagon road crossing, and 68 meters below Saxtonholm Depot.

Elevation, 8.5852 meters. 28.167 feet.

B. M. $2\frac{1}{2}^7$ is top of copper bolt in vitrified-clay slab in ground on east bank on lower edge of first ditch below upper line of the Ducross plantation. Is 10 meters back of N. O. and S. Railway, and about 100 meters above dwelling and about 31 meters back of levee.

Elevation, 7.7602 meters. 25.460 feet.

B. M. $2\frac{1}{2}^7$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^7$, described above.

Elevation, 8.9632 meters. 29.407 feet.

P. B. M. 37 is top of copper bolt in vitrified-clay slab in ground on east bank on land of Willis Fassy. It is 510 feet below D. Danterives's house, and 6 meters back of N. O. and S. Railway and on west side of small ditch. To △ battle ground 149° 29′ 07″, 1,213.3 meters; to refinery chimney 91° 51′ 02″.

Elevation, 8.5847 meters. 28.165 feet.

P. B. M. 37 A is top of cap on top of pipe over P. B. M. 37, described above.

Elevation, 9.7841 meters. 32.100 feet.

B. M. $2\frac{1}{2}^8$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Mrs. Alberdine, and at rear end of lane. Is 290 meters back of levee. Is in fence corner 57.5 meters from the northwest corner of house occupied by Louis Heier, 2 miles below Jackson Barracks, New Orleans, to △ battle ground 245° 57′ 09″, 1,742.4 meters.

Elevation, 8.4140 meters. 27.605 feet.

B. M. $2\frac{1}{2}^8$ A is top of cap on top of pipe over B. M. $2\frac{1}{2}^8$, described above.

Elevation, ——— meters. ——— feet.

T. B. M. 162, is nail in root of 15-inch tree at inner base of levee, and 6 meters east of the east line of Jackson Barracks, New Orleans.

Elevation, 11.2022 meters. 36.753 feet.

P. B. M. 38 is top of a vertical copper bolt in base of the second column on east side of the sally port on inside of inclosure at Jackson Barracks, New Orleans. The letters U. S. P. B. M. are cut near the bolt.

Elevation, 9.5194 meters. 31.232 feet.

T. B. M. 165 is nail in root of 15-inch hackberry on south side of St. Claude street and 40 feet eastward from intersection of St. Claude and Elizardi streets, New Orleans.

Elevation, 7.4776 meters. 24.533 feet.

B. M. $\frac{2}{1^{A}}$ A is top of cap on top of pipe over B. M. $\frac{2}{1^{A}}$. Is on east side of Forstal street about 18 inches from east fence and is 346.2 meters northward from the N. O. and S. Railway, New Orleans. To St. Maurice 325° 58′ 55″, 1,409.8 meters; to Ursulines Convent 47° 06′ 05″ 1,149.7 meters.

Elevation, 7.7003 meters. 25.264 feet.

T. B. M. 166 is nail in root of 15-inch live oak 6 feet from north side of St. Claude street and about 50 meters west of Lesseps street, New Orleans.

Elevation, 7.3769 meters. 24.203 feet.

P. B. M. 39 is top of vertical copper bolt in the granite doorstep at east entrance of the Academy of the Holy Angels, at the northwest corner of Congress and Rampart streets, New Orleans. The bench mark is at the Congress street entrance and is 1 inch from front of step and five inches from south jamb.

Elevation, 7.7862 meters. 25.546 feet.

P. B. M. 40 is center of horizontal copper bolt in the brick wall around the Church of the Annunciation, at the northeast corner of Mandeville and Marais streets, New Orleans. The bench mark is on Mandeville street and 3.2 meters north of the north line of Marais street. Is in the center of a buttress and in the sixteenth course of bricks above the pavement.

Elevation, 8.6295 meters. 28.312 feet.

T. B. M. 41 is top of a vertical copper bolt in brick pier under south post of the electric light tower at the southwest corner of Anthonia and Claiborne streets, New Orleans. It is 3 inches east of the southeast corner of the iron bed plate and about 2 feet inside of the curb line on the west side of Anthonia street and 2.7 meters south of the southwest corner of Anthonia and Claiborne streets.

Elevation, 6.5281 meters. 21.418 feet.

T. B. M. 170 is nail in east root of 15-inch oak tree on west side of St. Bernard street and 75 meters north of Aubrey street, New Orleans.

Elevation, 6.6166 meters. 21.708 feet.

T. B. M. 171 is nail in root of 12-inch elm tree on south side of Claiborne street, 80 meters west of Esplanade street and 52 meters east of brick culvert in New Orleans.

Elevation, 7.6022 meters. 24.942 feet.

T. B. M. 175 is a + cut on the iron bed plate supporting the southern post of the electric-light tower at the corner of Lapeyrouse street and Gentilly road, New Orleans.

Is marked thus: U + S, with chisel in the iron surface.

Elevation, 6.9964 meters. 22.954 feet.

P. B. M. 42 is a + cut on top of south end of granite step of the Crescent City Brewing Company's building at the southeast corner of Claiborne and Canal streets, New Orleans; is marked thus: U. + S.

Elevation, 7.6264 meters. 25.021 feet.

P. B. M. 43 is top of a vertical copper bolt set in the marble monument established by the U. S. Coast and Geodetic Survey for an astronomical station in Lafayette Park, New Orleans. The top of the bolt is flush with the top surface of the stone and is marked thus: U. S. P. B. M. ⊙

Elevation, 10.2066 meters. 33.486 feet.

U. S. P. B. M. 3, established by the Mississippi River Commission in 1882, is a horizontal mark on end of horizontal copper bolt in the east face of the middle brick gate-post of the Gentilly gate, on east side of the fair grounds at New Orleans. The bench mark is in the fifth course of bricks above the ground, and is marked thus: U. ⊙ S.

Elevation, 7.6658 meters. 25.150 feet.

U. S. P. B. M. 2, established by the Mississippi River Commission in 1882, is the center of end of horizontal copper bolt in the northwest face of the southern wing of the abutment at the northwest end of the drawbridge over Bayou St. John, on the Esplanade Road, New Orleans. It is marked thus: U. S. ⊙ P. B. M.

Elevation, 9.1586 meters. 30.048 feet.

B. M.—City stone, "Halfway House" is a + on top surface of a granite marking-stone set in ground, on west side of canal, near entrance to Metairie Cemetery, New

Orleans. The top of the stone is 120 millimeters by 200 millimeters and is in line with the fence along the south side of the cemetery, and is 4.7 meters from the southern end of the wall forming the cemetery entrance, and is 41 meters from the western end of the bridge crossing the canal.

Elevation, 7.9870 meters. 26.204 feet.

APPENDIX 3 E.

REPORT OF ASSISTANT ENGINEER J. A. OCKERSON ON LOCATION AND CONDITION OF GAUGES.

ST. LOUIS, MO., *December 26, 1892.*

SIR: I have the honor to submit the following report on inspection of Mississippi River Commission gauges made in the months of November and December, 1892.

The steamer *Patrol*, with the topographical party on board, reached St. Louis on November 15, and as the steamer was assigned to work on the lower river from Donaldsonville down, the opportunity was most favorable for a thorough inspection and repair of the gauges and bulletins on the way down to that point.

The party left St. Louis on November 17, and en route reëstablished all of the gauges and repaired or replaced all of the bulletin boards maintained by the Mississippi River Commission.

New bench marks were set at several stations where the old ones had been destroyed or where they were located too far away from the gauges for convenience. These benches were established by means of duplicate lines of levels from one or more reliable benches in the vicinity. This often necessitated levelling over long distances, but will make future inspections much easier. Many of the earlier benches were on trees, and most of them have been destroyed by decay caused by the blazing of the tree for the bench, or the tree has fallen from the force of winds or caving banks.

Most of the gauges are essentially temporary, as caving banks, drift, etc., make permanent structures impracticable, and can only be kept up by the vigilance of the observers, supplemented by a thorough inspection at high and low water. Some of them are also temporary from another cause. The changes in the bed and banks of the stream precipitate a heavy fill, thus necessitating a change of location. Morrissons and Mhoons are notable examples. In the latter case the gauge is now nearly 2 miles downstream from its original site. The gauge zero has been kept the same, hence it is evident that the relations between the present readings and the earlier ones can only be reached by taking into consideration the slope, which may amount to nearly a foot. In the discussion of gauge relations at different periods, it is important that this should be noted.

Where a fill is likely to occur a new gauge should be established under a new name to avoid confusion in the records, and the two gauges should be read for a period (preferably covering one high and one low water) long enough to establish the relations between the gauges.

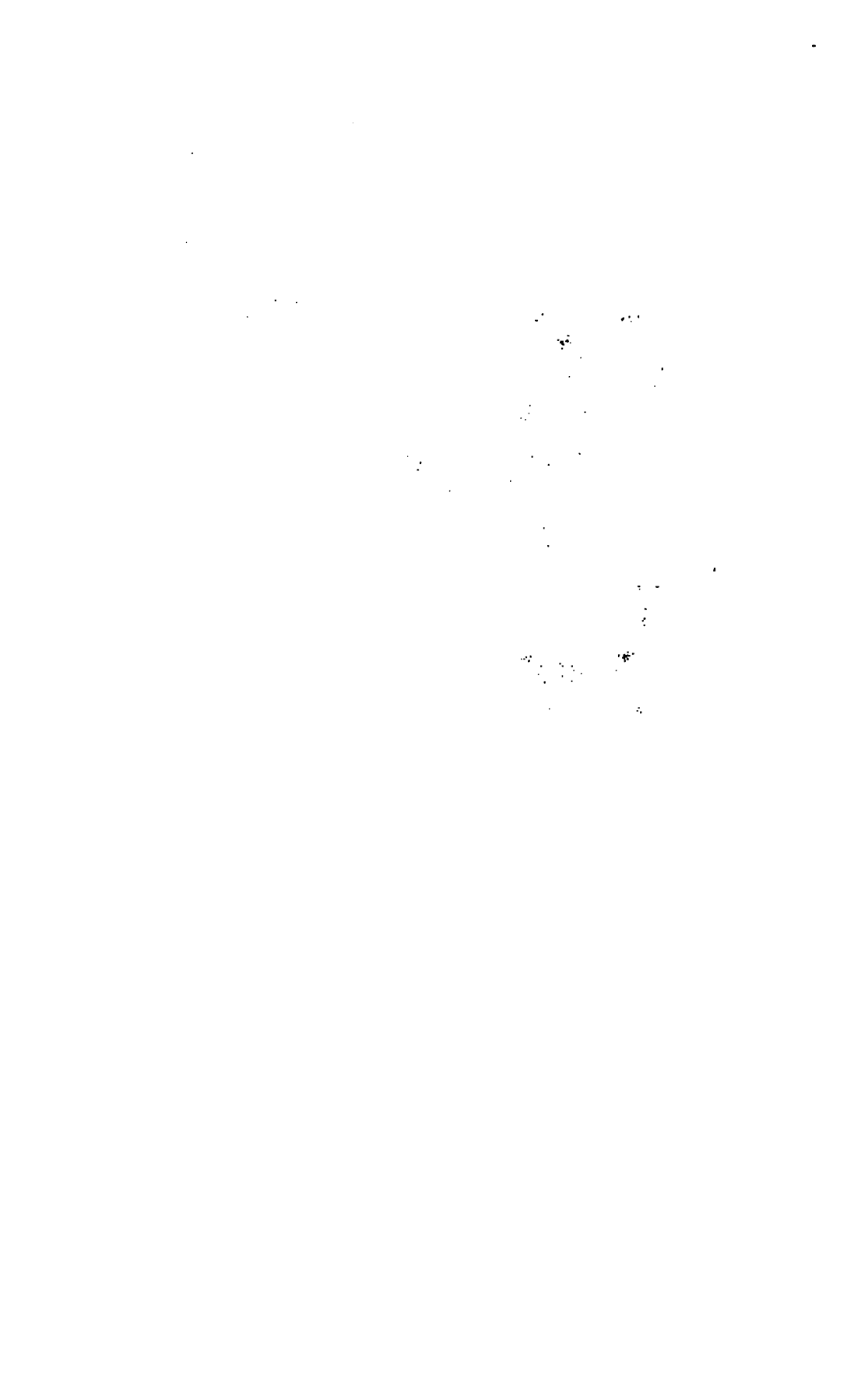
The gauges which have been set with the zero above low water have been a fruitful source of error and annoyance. The records of the observers are full of mistakes when the zero is passed. The pilots also find it difficult to reconcile the bulletin readings, which at one point give 1 foot, and the next station 5 feet, when the actual stage is known to be the same.

It is very doubtful whether the possible confusion in the records, arising from a change of all the gauges so that the zeros would be at or below extreme low water, would outweigh the decided advantage of wiping out for all time to come the chief cause of error and confusion in the present records.

It has already been noted that changes of location from natural causes are sometimes imperative. If an occasional change of this kind, which might easily be overlooked, is not seriously objectionable, then a general change of the whole system would be still less so, as it would be so radical as to be generally known.

The first gauge bulletins erected were found to be too small, and the figures were too indistinct. The next size was somewhat larger, and later a still larger figure was brought into use.

The frames for the last named were made so that the figure plates were set in grooves. This arrangement looked quite simple, but has proven very unsatisfactory, owing to the difficulty of handling such large plates during even a moderate wind. Another objection is that the plates, being easily detachable, are often dropped and become battered, and then will not enter the grooves, or they may be carried away entirely.



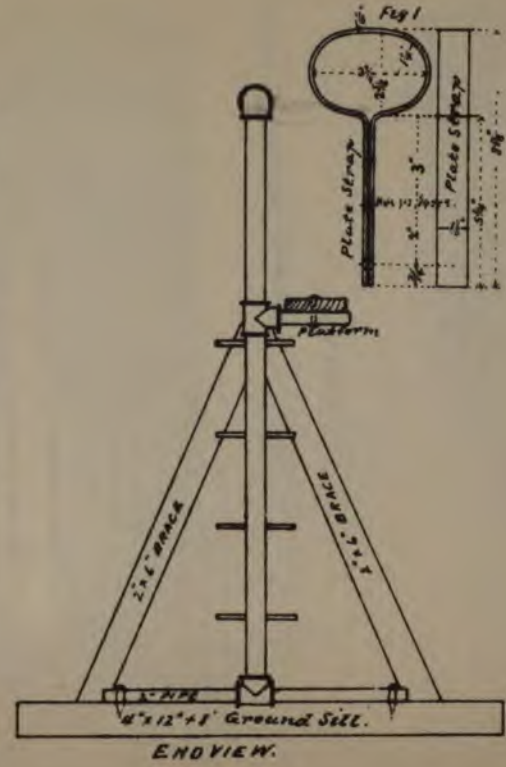
RIVER STAGE BULLETIN

1892.

Scale 1" = 3'1" +

Figure Plates of No 20 Iron, Galvanized
Malleable Fittings and Pipe do.
Plates have iron straps at upper end (Fig 1)
passing around pipe A, and revive
freely on same.

J. H. Osborne
Assist. Engr



END VIEW.

To remedy these defects a new bulletin frame was designed, made entirely of gas pipe. Three of these were put up. The appended drawing renders a detailed description unnecessary. New gauges were established at New Madrid and the Iron Mountain and Southern Railway Bridge across the St. Francis River. These are to take the places of the Morrissons and Wittsburg gauges, respectively, as soon as the gauge relations have been established by a sufficient period of readings.

The gauge at Yazoo City was not inspected, as it was to be soon abandoned.

Donaldsonville was reached on December 7, and assistants A. T. Morrow and George H. French joined at that point. The *Patrol* and party was turned over to Mr. Morrow, and after the inspection of the College Point gauge the other stations were reached by mail or local steamboat.

The work of inspection was finished on December 14, and my duties in the office resumed on the 15th.

Respectfully submitted.

J. A. OCKERSON,
United States Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

Gauge at Grays Point, Mo. Distance from Cairo, 45 miles. R. Latitude, 37° 15′. Longitude, 89° 27′ + 1310^m. J. C. Gray, observer. Inspected November 18, 1892.—This gauge is in two sections and consists of straps of iron bolted firmly to the solid rock, and hence it may be considered permanent.

The bench marks to which the gauge is referred could not be found. They are probably covered with the soil which has been carried down from the higher elevations, and the descriptions are too meager to locate them. They are doubtless still intact, and any section of the gauge is quite as good as a special bench mark.

The bulletin was repaired and repainted.

Gauge at Belmont, Mo. Distance from Cairo, 21.3 miles. R. Latitude, 36° 46′ + 35^m. Longitude, 39° 07′ + 440^m. T. H. Parker, observer. November 20, 1892.—This gauge is located on the piling at the lower side of the elevator warehouse, as shown in accompanying sketch.

Both B. M. No. 2 and B. M. No. 3, given in stage pamphlet, have been destroyed and a duplicate line of levels was run from B. M. $\frac{3}{}$, which, from its position in an angle of the fence and its general appearance, is probably the same elevation as when set.

All of the sections of the gauge are firmly spiked to the piling and practically unmovable. The sections from 5 to 46 feet were consistent with one another. With reference to B. M. $\frac{3}{}$, they are, however, about 0.25 feet too low. The lower section (from 5 feet down) was found to be 0.03 feet too high from the same bench.

The reference benches were gone, and consequently there was no way of verifying the old determinations. The gauge sections have every appearance of being in same position as when set, and it was assumed that there was some good reason for setting the upper sections as they were found, and reasons which might perhaps be given in some of the inspection reports on file in the office. So on the whole it was thought best to make the entire gauge consistent by changing the short section, and this was consequently done.

If the elevation of B. M. $\frac{3}{}$ is correct, then the zero of the entire gauge as it now stands is 0.25 feet too low. This value would have been verified by a river crossing from a P. B. M. in Columbus, had it not been that a high wind prevailed, making such work impracticable, and it was not deemed advisable to detain the *Patrol*.

As the inspection reports on file in this office do not give any clue to the differences found, it is important to check the value by river crossing from P. B. M. 8, as suggested.

The following bench marks were set from B. M. $\frac{3}{}$:

B. M. 1, 1892, is the top of a railroad spike driven horizontally into southeast side of cypress pile standing at northeast corner of elevator superintendent's house. It is marked with tacks B. $\frac{1}{\odot}$ M. Elevation, 330.46.

B. M. 2, 1892, is highest point of railroad spike driven horizontally into south side of an oak pile standing 21.6 feet below elevator and 2.3 feet east of east line of elevator. It is marked with tacks B. $\frac{2}{\odot}$ M. Elevation, 331.69.

The bulletin is placed on top of the elevator warehouse. All of the plates and frame were repainted.

Gauge at Morrissons, Mo. Distance from Cairo, 69 miles R. Latitude, 36° 34′+700″. Longitude, 89° 29′+980″. Miss Bettie Morrisson, observer. November 21, 1892.—The gauge is located opposite upper side of yard surrounding the Morrisson residence, 1¼ miles above the main street of New Madrid, Mo. The gauge is now in seven sections, and only the upper one (from 34 to 43 feet) is permanent. This section is nailed to a sycamore tree standing at southeast corner of yard around the Morrisson residence.

The other sections are 2 by 6 inch scantling driven at intervals down the sloping bank and read as follows: Section 2, 30 to 34.3 feet; section 3, 26 to 30 feet; section 4, 20 to 27 feet; section 5, 13 to 20 feet; section 6, 10 to 16 feet; section 7, 0 to 10 feet.

All of these sections were set and driven as firmly as practicable. Section 4 was found to be 0.53 feet too low. All of the other sections were corrected within 0.1 foot. These sections all are temporary and may readily be destroyed by drift or other causes. The bank has a gentle slope and does not cave, particularly since the bar has formed in the bend. This bar connects with the shore about a mile above the gauge, and from about the 10-foot stage down the readings are taken in a pocket and hence do not bear the proper relations to the higher-stage readings, as the gauge registers the elevation of the water surface at or below the foot of the bar. The readings below the stage where the bar cuts off the water are therefore too small by about 0.2 feet. This would apply to the low-water readings of the past two or more years.

This gauge will be discontinued when the relations between it and the new gauge at New Madrid have been determined.

Gauge at New Madrid, Mo. Distance from Cairo, 70.3 miles R. Latitude 36° 35′. Longitude 89° 31′. W. O. Smith, observer. November 22, 1892.—A gauge was established at the mouth of St. Johns Bayou, on lower side of same, 860 meters above the main street of New Madrid, Mo.

The banks in front of New Madrid are very high and are chiefly a light, sandy soil. They cave badly and a gauge could not be maintained below the mouth of St. Johns Bayou. The caving is not so extensive in this vicinity, and the sloping bank of the bayou made it practicable to put in a sloping gauge from 9.4 to 23.8 feet. The bayou is used for running out logs at medium to high stages, and an upright gauge could not be maintained there on that account.

The local effect of the bayou may be felt in the stage readings. But as the gauge is only a few feet from the river it does not seem probable that the influence of the bayou can be very great.

Below 9.4 feet a temporary gauge must be used.

The sloping gauge consists of a 6 by 8 inch timber, placed near the ground and held in place by being driftbolted to 10 by 12 inch posts set 5 feet deep at intervals of 6 feet. The feet and tenths are marked by notches cut in the surface of this timber, the figures at footmarks being put in with tacks.

The sections above the 23-foot mark are firmly spiked to trees and are practically permanent.

An iron bulletin was erected on the high bank just above the sawmill.

A tile and pipe B. M. and a tree B. M. were established from B. M. $\frac{1}{7}$ with a duplicate line of levels, and a line was also run from B. M. 4 at Morrissons. There is a discrepancy in the determinations of the values of these two benches of 0.24 feet.

The elevation of the zero of the New Madrid gauge was made the subject of special investigation in May, 1890 (see note book 1872), and a line of duplicate levels were run from P. B. M. 22 and connecting on the way with B. M. $\frac{20}{8}$, $\frac{1}{9}$, $\frac{1}{7}$, $\frac{1}{3}$, B. M. 4, and $\frac{1}{9}$. This line showed a discrepancy between $\frac{1}{7}$ and B. M. 4 of 0.27 feet, which differs only 0.03 feet from that found in this inspection. The other values were found to accord with previous determinations, so that the fact is well established that B. M. 4 is practically correct, while $\frac{1}{7}$ is too low 0.255 feet.

The elevation of the zero of the gauge and gauge bench-marks at New Madrid are based on this conclusion and are as follows: Zero of gauge, 275.72, above Cairo datum.

B. M. 1, 1892, is tile and pipe set in woods about 200 feet north of gauge. It is near wagon road and on line between an osage orange tree 6 inches in diameter and a thorn tree 12 inches in diameter. It is 6.5 feet from the osage orange tree and 26.5 feet southeast of the thorn tree. Both trees are blazed on side toward B. M. and the thorn tree is marked B. M. 1, with tacks. Elevation above zero of gauge pipe 27.83 feet, tile 22.86 feet.

B. M. 2, 1892, is nail in root of gum tree standing north of sloping gauge. It is the first tree south of sycamore on which section of gauge is nailed.

Section 22.5 to 32 feet is firmly spiked to river side of a 24-inch sycamore tree standing 75 feet north of sloping gauge.

Section 31.7 to 45 feet is spiked to southwest side of an 18-inch gum tree, standing 30 feet northwest of above-described sycamore. It is 100 feet southeast of pipe B. M. and nearly on line between sycamore and pipe B. M.

Gauge at Cottonwood Point, Mo. Distance from Cairo, 123.0 miles. R. Latitude, 36° 03′ + 1460ᵐ. Longitude, 89° 41′ + 290ᵐ. H. C. Garrett, observer. November 24, 1892.—This gauge is located directly in front of Dr. Tipton's house, at Cottonwood Point, Mo.

All of the sections, except the high-water section (35 to 40 feet), are temporary. The high-water section is firmly spiked to the downstream side of a large cottonwood tree standing in front of and near the schoolhouse. The other sections are posts and stakes of various kinds set at intervals down a gently sloping bank. Several of the upper sections were set near Dr. Garrett's house, about 3,000 feet above the present location, which coincides with original location of gauge. The highest section (36 to 41 feet) at Dr. Garrett's was 0.12 foot too high and the sections from 16 to 25 feet were about 0.1 foot too low. The sections at Dr. Tipton's were practically correct.

As rebuilt opposite Dr. Tipton's, the sections are as follows: Section 1, 0 to 3 feet; 2, 3 to 6.5 feet; 3, 6 to 12 feet; 4, 12 to 14.2 feet; 5, 14 to 18.9 feet; 6, 18.9 to 23.5 feet; 7, 23.5 to 31 feet; 8, 31 to 36 feet; 9, 35.3 to 40 feet.

The old bulletin was out of order and was replaced by an iron one.

A duplicate line of levels was run from B. M., ⓐ north base, near Dr. Garrett's house, to a pipe and tile B. M., which was set near the gauge at Dr. Tipton's and described as follows:

B. M. 1, 1892, is pipe and tile set just back of bulletin at northwest corner of yard surrounding Dr. Tipton's house. Elevation above zero of gauge, pipe, 36.81; tile, 32.83.

Gauge at Fulton, Tenn. Distance from Cairo, 175.4 miles L. Latitude, 35° 37′ + 175ᵐ; longitude, 89° 53′ + 115ᵐ. W. W. Butler, observer. November 25, 1892.—This gauge is located on the left bank (downstream side) of a prominent gully situated about 400 feet above the landing at Fulton, Tenn. All of the sections should be classed as temporary, as they are composed of scantling and posts set at intervals down a sloping bank.

All of the sections standing were found correct except 31.5 to 36 feet, which was 0.23 foot too low, probably caused by settling of warehouse, as it was attached to one of the blocks supporting same.

The gauge was rebuilt from 13 to 36 feet. The sections from 0.0 to 34.5 feet are at original location of gauge. A high-water section 31.5 to 36 feet was spiked to one of the posts supporting the lower side of the warehouse at landing.

The bulletin was repaired and repainted.

A duplicate line of levels was run from P. B. M. 42 in order to establish a tile and pipe B. M. near the gauge to take the place of the old gauge B. Ms., which have been destroyed.

B. M. 1, 1892, is a tile and pipe B. M. set back or inland from gauge about 75 feet. It is near foot of bluff on right bank (upstream side) of gully, and about 400 feet above Fulton Landing. It is about 110 feet back of (south) vertical face of bluff lying along river, just above mouth of said gully. On this bluff stands a building marked "U. S. Engineer Office."

The B. M. is on line between a 24-inch gum tree, standing on the flat ground, and a 15-inch beech tree standing at top of hill.

B. M. is about 10 feet east of gum tree and about 45 feet west of beech tree. Both trees are blazed on side toward stone, and gum tree is marked with tacks B. M. 1. The elevation is: Pipe, 37.87; tile, 33.89 above zero of gauge. A tree marked B. M. A. reads 36.63 feet on gauge. A tree B. M. B. reads 33.10 on gauge. These tree B. Ms. were probably set by the construction party at Plum Point.

Gauge at Mhoon Landing, Miss. Distance from Cairo, 277.3 miles L. Latitude, 34° 43′ + 1,750ᵐ. Longitude, 90° 28′ + 80ᵐ. G. E. Thomas, observer. November 28, 1892.—This gauge is located on the left bank of the river 1,685 meters below B. M. $\frac{1}{2}$, about a mile and a half below the original location of gauge and just above the present Mhoon's Landing.

All of the sections of this gauge, except the upper one, are temporary posts set at intervals down a sloping bank. The gauge was rebuilt from 0 to 40 feet. All of the gauge at this point, except the high-water section, which is nailed to a tree, was destroyed about August 15, 1892, by the bank settling down bodily, and the observer read on a temporary peg from that time to date of inspection.

As rebuilt the sections read as follows: Section 1, 0 to 6 feet; 2, 6 to 11 feet; 3, 11 to 16 feet; 4, 16 to 25 feet; 5, 25 to 31 feet; 6, 29 to 35 feet; 7, 35 to 40 feet. The latter is spiked firmly to a large cottonwood tree. A ship spike is driven in upper side of same tree with upper side of head reading 35 feet on gauge.

A duplicate line of levels was run from B. M. $\frac{1}{2}$ to establish these sections of the gauge.

The bank in the vicinity of the gauge is in bad condition and the gauge consequently in danger of being destroyed at any time. The bulletin is in good condition, but is the grooved style, which is very difficult to manipulate.

It will be noticed that the present position of the gauge is nearly 2 miles below its original position, and the zero is kept at the same elevation. It was moved down in consequence of a fill in the bend.

The slope for the above distance at high water would be about 0.9 foot; hence the gauge relations between this gauge and those at Helena and Memphis have changed by this amount. That is, to compare with the gauge relations in its old position, the present readings should be about 0.7 foot greater than they now are.

The difficulties of maintaining the gauge in its present position on account of caving banks, its remoteness from reliable observers, the fact that it is no longer in its true relations with the gauges above and below, and that the zero is nearly 2 feet above low water, suggests the desirability of moving it.

An excellent place could be found for it, free from most of these defects, on the right bank near foot of Bordeaux Island, about 5 miles below its present site.

It could be set just far enough above the mouth of the "Old River" to protect it from caving and the drift, and in this position would remain intact for a long time. It would be about 50 miles from the Memphis gauge.

Gauge at Sunflower Landing, Miss. Distance from Cario, 352.7 miles L. Latitude, 34° 10′ + 655 ᵐ. Longitude, 90° 48′ + 865ᵐ. S. F. Bunch, observer. November 29, 1892.—This guage is situated on the left bank of Mississippi River at mouth of Hushpucana Creek and a few feet above Sunflower Landing.

At this gauge the two upper sections, 28.5 to 39 feet and 37 (?) to 43 feet, may be considered permanent, as they are spiked to trees. The other sections are 2 by 6 inch posts set at intervals down the bank and consequently temporary.

The limits of the temporary sections are as follows: 1, 0 to 7 feet; 2, 6 to 11 feet; 3, 11 to 15 feet; 4, 15 to 19 feet; 5, 17 to 21 feet; 6, 20.5 to 25 feet; 7, to 24.5 to 29 feet.

The section in the water at the time of inspection read 5.68, while the levels from the upper high-water section made it 7.53. That is the readings were too small by 1.85 feet. The next standing section above the one in the water read from 23 to 31, and its readings were only 0.06 foot too small.

The observer could not offer any explanation of the discrepancy, except that on one or more occasions he had set his gauge arbitrarily, in consequence of its having been disturbed by settling with the bank. The only alternative, therefore, seems to be to consider the error cumulative and correct the readings accordingly below the 23-foot mark.

All of the sections from 0 to 28.5 were reset.

The bulletin was found to be in good condition, but is very difficult to manipulate.

This gauge zero is 0.15 foot too low according to the determinations of the levee engineers, who claim to have found a discrepancy of that amount in elevation given for B. M. $\frac{A}{1}$ as determined by running duplicate lines from a P. B. M.

Gauge at Arkansas City, Ark. Distance from Cairo, 438.3 miles R. Latitude, 33° 36′ + 180ᵐ. Longitude, 91° 12′ + 680ᵐ. J. M. Whitehill, observer. November 30, 1892.—This gauge is located on the railway incline a short distance below the elevator or freight house at Arkansas City. All of the old sections were found to be correct within 0.1 foot; all are attached to piling and consequently are quite stable. The high-water section, 39 to 51 feet, is attached to piling near water tank, standing about 125 meters above freight warehouse or elevator.

Sections of the gauge read as follows: 1, 0 to 8 feet; 2, 5 to 14 feet; 3, 13 to 20 feet; 4, 19.5 to 29 feet; 5, 27 to 42 feet; 6, 39 to 51 feet.

The first four sections are attached to the piling of the railway incline. The fifth section is on pile in front (river side) of water tank above elevator and near the sixth section.

The bulletin was rebuilt at the upper corner at the warehouse.

Coast survey P. B. M. F. was connected with and its elevation reads 42.43 feet above zero of gauge.

The gauge zero was determined by levels in duplicate from B. M. A. (Ewens, 1886) and P. B. M. F. (Coast Survey).

Gauge at Greenville, Miss. Distance from Cairo, 478.3 miles, L. Latitude 33° 24′ + 1,380ᵐ. Longitude, 91° 04′ + 90ᵐ. W. M. Green, observer. December 2, 1892.—This gauge is on the downstream row of piling supporting the garbage dump at foot of Main street, Greenville, Miss., and is quite stable. All of the sections except the upper one (41.5 to 45.5) were found to be correct within 0.1 of a foot. The foot marks being worn, the old sections from 16 to 45 feet were replaced by new ones. The short section (41.5 to 45.5) was left standing attached to a pile near shore end of dump.

The building on which P. B. M. 1, C. and G. S., was placed is now called "City Jail" instead of "Bank Building." B. M. A. 1892 was set at First National Bank building on first corner of Main street east of city jail and on south side of said street. It occupies the same position on iron door sill of bank building as P. B. M. 1 does on sill of city jail. It is 43.55 feet above zero of gauge and 0.24 feet above P. B. M. 1, Coast and Geodetic Survey.

The bulletin is near the gauge and is in good condition.

This gauge is also watched at high water by the levee engineers, and hence the record at this period may be accepted as reliable.

Gauge at St. Joseph, La. Distance from Cairo, 648.3 miles, R. Latitude 31° 53′+ 1,492m. Longitude 91° 14′+630m. Robert Worrell, observer. December 4, 1892.—This gauge is situated about half a mile below the town of St. Joseph, La., and near the residence of Capt. Robert Worrell. The high-water section, 40 to 46 feet, is spiked to the levee side of a large cottonwood tree standing a short distance above warehouse and on river side of "front levee." A large ship spike is driven in same tree at 41-foot mark.

The other sections are 2 by 6 inches set at intervals down the bank and read as follows: Section 1, 0 to 4 feet; 2, 3.5 to 9 feet; 3, 8.5 to 13 feet; 4, 12 to 17 feet; 5, 16 to 21 feet; 6, 21 to 27 feet; 7, 26 to 32 feet; 8, 31.5 to 38.9 feet; 9, 30 to 41 feet.

These sections are located about 500 feet below Capt. Worrell's house.

All of the sections of the old gauge, the bulletin, and also B. M. A., Ewens, were destroyed by a sudden caving of the bank, at which time a large area sank bodily into the river. The temporary gauge in the water was found by duplicate line of levels from B. M. No. 1, Hider (1881), to be 1.03 feet too high; that is, readings were too small by that amount. The observer could not account for the discrepancy, but thought most of the error came in after the caving noted above. The observer had pegged down the bank, as the water receded, from the 30-foot stage and part of the time the readings were taken during Mr. Worrell's absence by a young clerk, and the blame of the discrepancy seemed to rest on the latter.

There is, however, no well-defined break in the results, and the discrepancy can only be adjusted by regarding it as cumulative.

A new iron bulletin was erected a short distance above Mr. Worrell's house.

Gauge at Bayou Sara, La. Distance from Cairo, 799.8 miles, L. Latitude 30° 45′+ 1,815m. Longitude 91° 23′+810m. L. H. Chisholm, observer, December 6, 1892.—This gauge is directly in front of the residence of Mr. B. T. White, situated on Front street, about 500 meters below the mouth of Bayou Sara. It consists of sections set at intervals down the sloping bank, with the exception of the upper sections, which are nailed to the sheet piling protecting the levee in front of Mr. White's house.

The errors found in the sections were less than 0.1 feet.

The gauge was rebuilt from 17.0 to 42.7 feet, and sections are arranged as follows: section 1, 0 to 7 feet; 2, 7 to 12 feet; 3, 11.5 to 17 feet; 4, 17 to 23 feet; 5, 21 to 28 feet; 6, 27 to 42 feet; 7, 38 to 42.7 feet. The two latter are nailed to the piling. The sections are nearly in line.

The levels were derived from B. M. A., Ewens (1889), which is in west front of Mr. White's house.

The bulletin is about 200 meters below mouth of Bayou Sara. It is very difficult to manipulate.

Gauge at Plaquemine, La. Distance from Cairo, 854.1 miles, R. Latitude 30°17′+ 1,170m. Longitude 91°13′+1,365m. Frank Turner, observer. December 7, 1892.—This gauge is situated at steamboat landing near foot of Main street, at Plaquemine, La. It consists of 2 by 6 inch sections set at intervals down the bank, at such points in the vicinity as promise the greatest degree of permanence. The gauge can only be maintained by vigilance and care of the observer, as it is so exposed to steamboats, rafts, and drift that the life of a section is generally very brief.

The levels were derived from B. M. A., Ewens (1883), and the zero of the gauge was found to be 0.21 feet too low.

A new low-water section (0 to 5 feet) and a new high-water section (28 to 35 feet) were placed. No sections were placed between them, owing to the impracticability of making them even in a slight degree permanent.

The point opposite would be an easier place to maintain this gauge.

The bulletin was demolished by a steamer during the high water in June, and the old bulletin was put up.

The large bulletin was put up at time of inspection about 140 meters below Main street, and on river side of levee.

Gauge at College Point, La. Distance from Cairo, 904.5 miles, L. Latitude 29° 59′ + 830m. Longitude, 89° 49′ + 500m. Ernest Subra, observer. December 8, 1892.—This gauge is situated at College Point, almost directly in front of Jefferson College. It consists of 2 by 6 inch posts set at intervals down a sloping bank and a high-water section spiked to a tree a short distance below the other sections of the gauge. Another high-water section (21.5 to 26.5) is nailed to the bulletin frame at ferry landing which is a short distance above the gauge.

All of the sections were found to be practically correct and read as follows: Section 1, 0 to 9 feet; 2, 6 to 17 feet; 3, 15 to 22 feet; 4, 21 to 28 feet. Levels were derived from the high-water section.

The bulletin is the grooved form for the figure plates. It is in good condition, but very difficult to manipulate.

This gauge is on the extreme end of College Point, and no difficulty is found in maintaining it. This suggests that on the stable banks of the river below mouth of Red River the gauges should all be on the points rather than in the bends.

Gauge at Fort Jackson, La. Distance from Cairo, 1,039 miles, R. Latitude, 29° 21 + 1,000m. Longitude, 89° 27′ + 830m. Peter E. B. Ostrom, observer. December 10, 1892.—This gauge is situated directly in front of ordnance sergeant's quarters and about 50 meters above the frame hospital building standing on river side of levee. It consists of a single post set vertically at the water's edge and braced from the top to the bank.

B. M. "A" is upper surface of a ship's spike driven horizontally into brick chimney at upper or west end of building known as "ordnance sergeant's quarters." The spike is in middle of the west face of the chimney, about 10 inches above the ground and in second course below weatherboarding of house. A × is cut in brick just under the spike. Top of spike reads 6.50 on gauge.

B. M. "B" is the upper surface of a nail driven in the brick pier supporting southwest corner of hospital building. Nail is in west face of said pier 2 inches from the southwest corner and between third and fourth courses below top of pier. H. is cut in pier just under nail. Top of nail reads 5.80 on gauge.

It should be noted here that the readings are affected by the tide and hence it is difficult if not impracticable to give accurately height of water due stage of river proper.

Gauge at Clarendon, Ark., on White River. W. N. Johnson, observer. December 13, 1892.—This gauge is in one section, attached to lower or downstream side of upper pier cylinder at east end of drawspan of Cotton Belt Railway Bridge crossing the White River at Clarendon.

The extreme high water reached 2 feet above the fixed gauge, and is read on a temporary gauge set by the observer near by.

Accumulation of drift at upper side of bridge sometimes affects the reading on gauge a few tenths of a foot.

The gauge proper is firmly attached to bridge, so that it is practically permanent.

The bulletin was replaced by a better one from one of the Mississippi River stations, instructions being left with observer to put it up in a conspicuous place at end of a new building in process of construction.

Gauge at Wittsburg, Ark., on St. Francis River. Miss Jimmie Smith, observer. December 14, 1892.—This gauge is located in the bend of the St. Francis River, just above the sawmill at Wittsburg, Ark.

From 3.8 feet to 43 feet the gauge is practically permanent, being firmly spiked to trees. Below the 3.8-foot mark temporary stakes are set to suit the changes in stage.

The gauge reads 3.5 feet below zero, and as the zero stage is passed there is much confusion in the records as to whether the stage is plus or minus. There is also considerable doubt as to the accuracy of the temporary gauge set at this point.

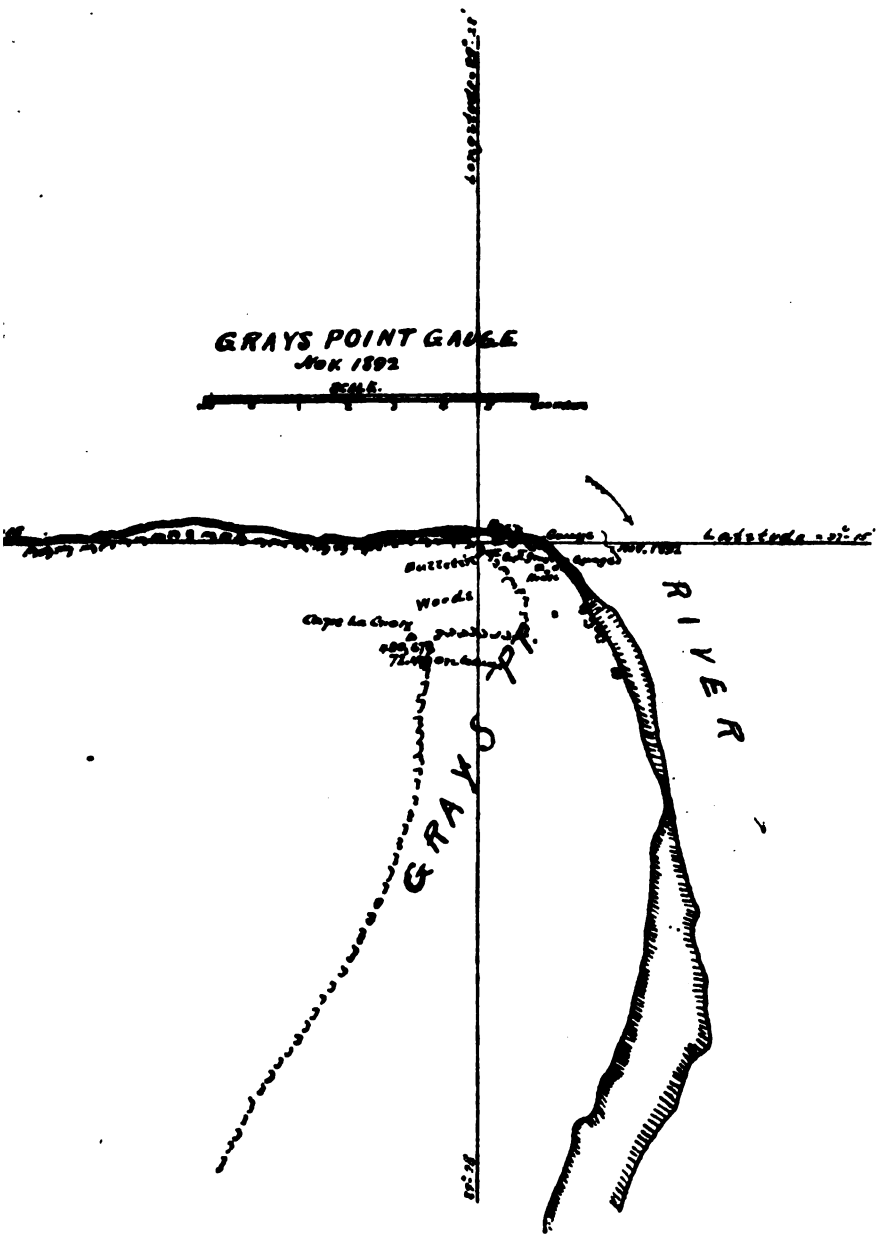
At time of inspection a sudden rise had just covered the temporary sections and they could not be tested. The bulletin is practically useless, as there are rarely any steamboats except at high water and even then the boats do not often come up as high as Wittsburg. The bulletin is small and of no value in any other situation.

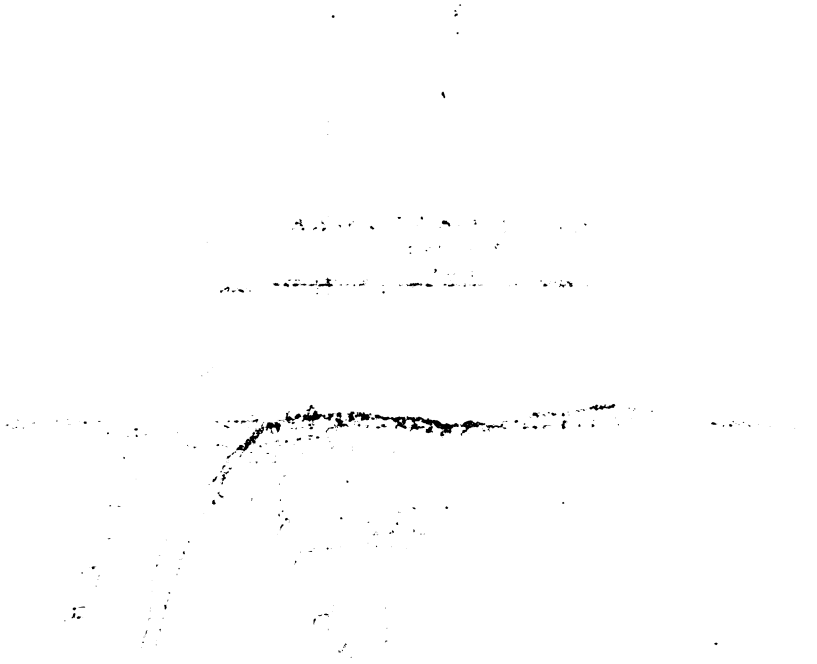
It is intended to abandon this gauge and substitute for it a new gauge at the Iron Mountain Railway crossing, about 14 miles farther up the river. The Wittsburg gauge will be abandoned as soon as the relation between the two gauges are determined by a sufficient period of readings.

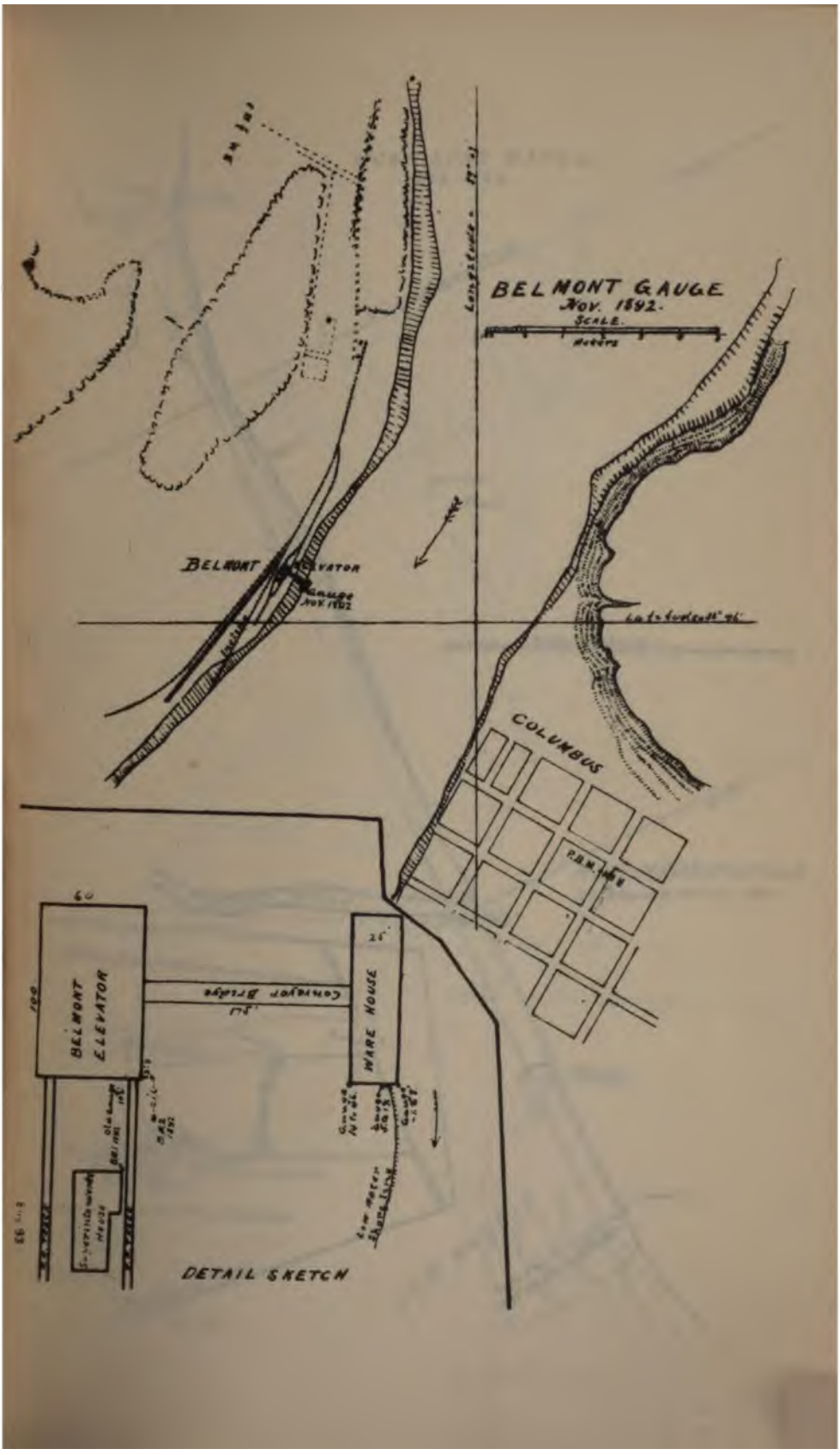
Gauge at Iron Mountain Railway Bridge across St. Francis River. G. W. Brown, observer. December 14, 1892.—This gauge from 6 feet up to high water is firmly attached in a continuous section to the trusses between the two cylinder piers at east end of draw of railway bridge across the St. Francis River, about 14 miles by river above Wittsburg, Ark. It is just below the upper cylinder at east end of drawspan of bridge. This gauge was placed December 14. The lower section will be placed when stage of water is low enough to permit. The bridge watchman, G. W. Brown, was appointed gauge-keeper. The result can be forwarded by mail from this point daily if desired.

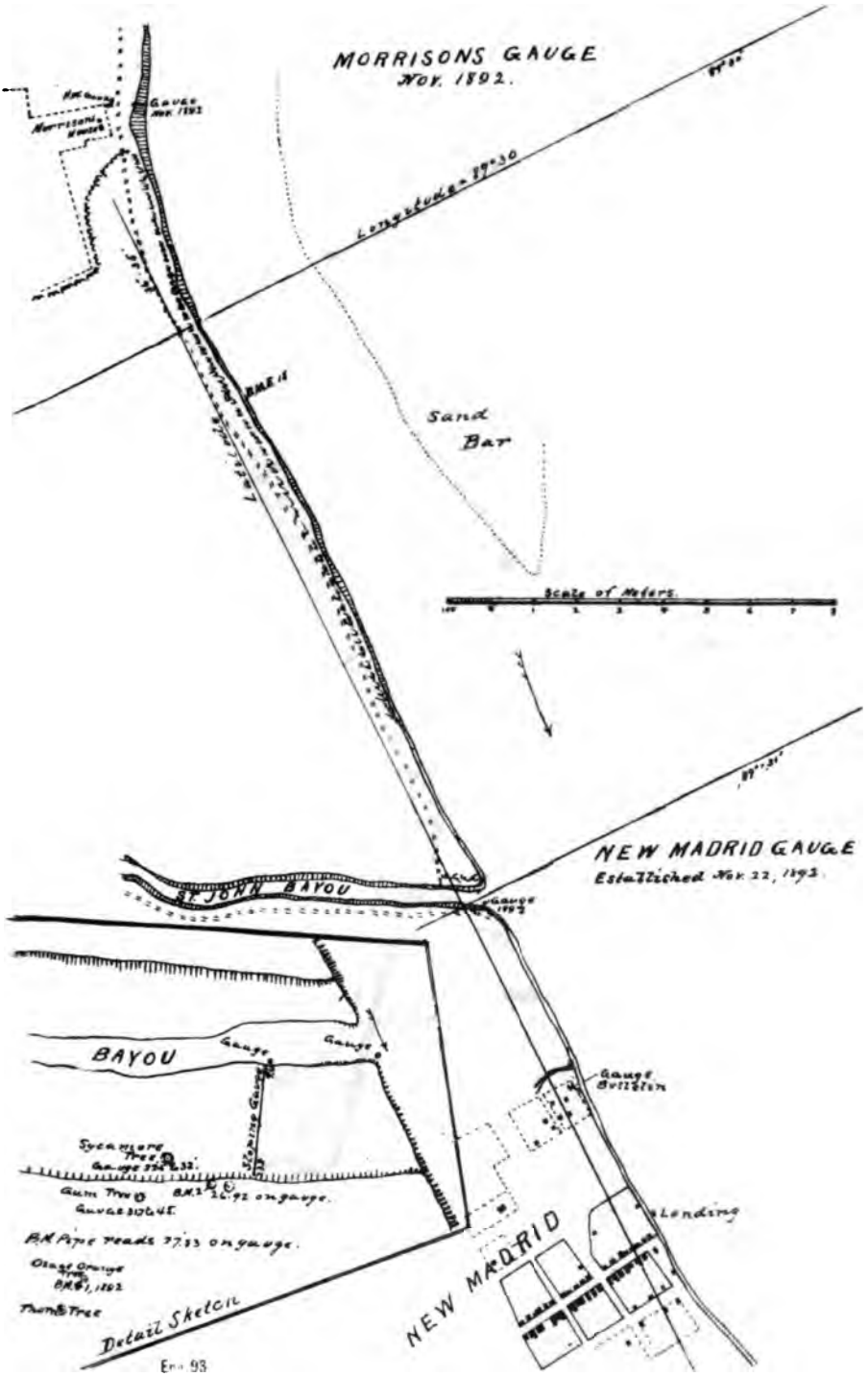
The upper side of bottom truss reads 9 feet on gauge. The upper side of upper truss reads 46 feet on gauge. The base of rail reads 53 feet on gauge. Railroad levels give base of rail = 229.5 feet above sea level, hence zero of gauge = 176.5 above sea level.

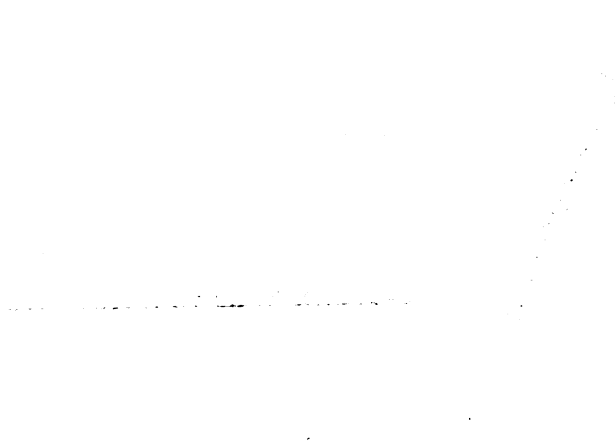
No bench marks were set, as the concrete piers were considered as permanent as any marks that could be made.

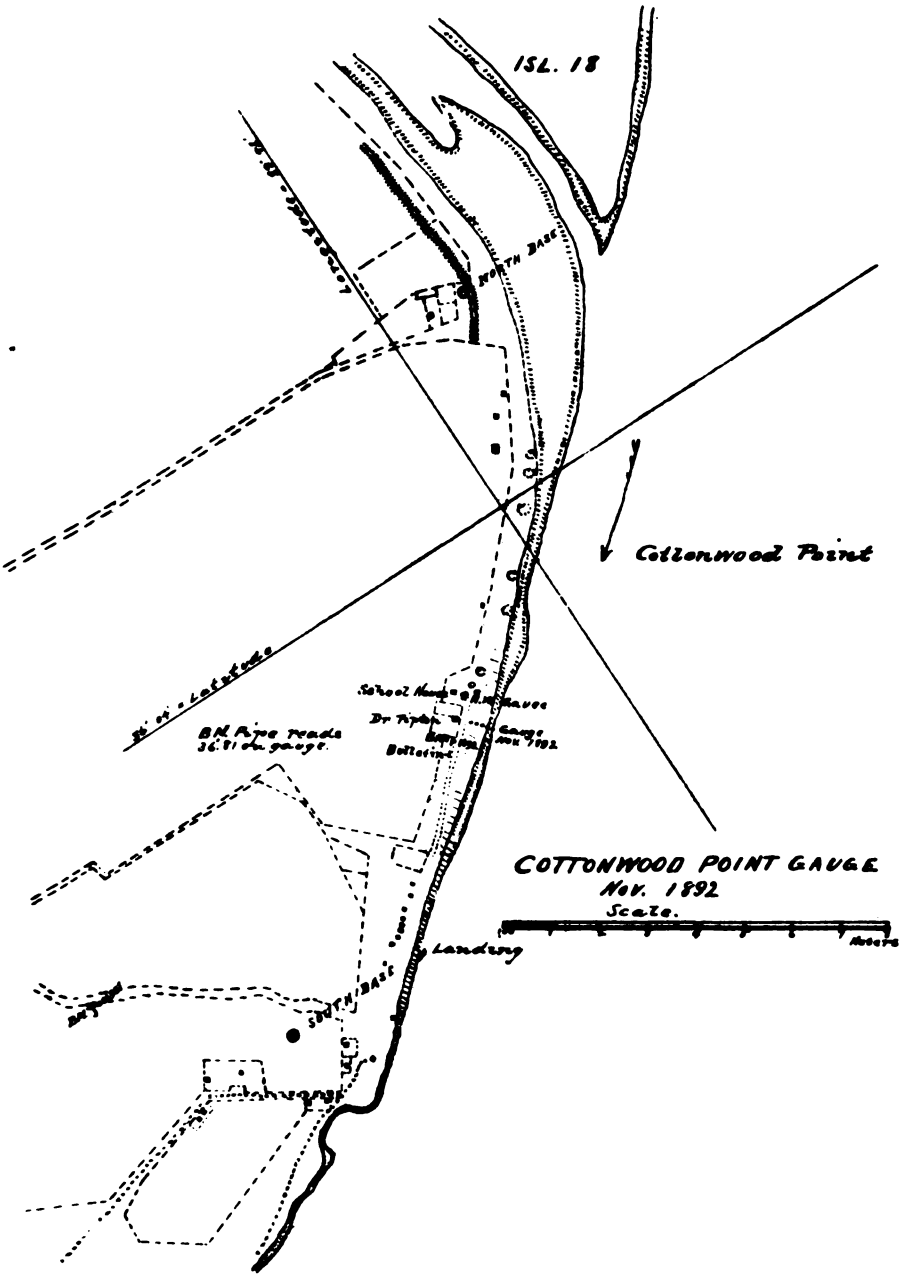

GRAYS POINT GAUGE
Nov. 1892
Scale.
RIVER
GRAYS POINT

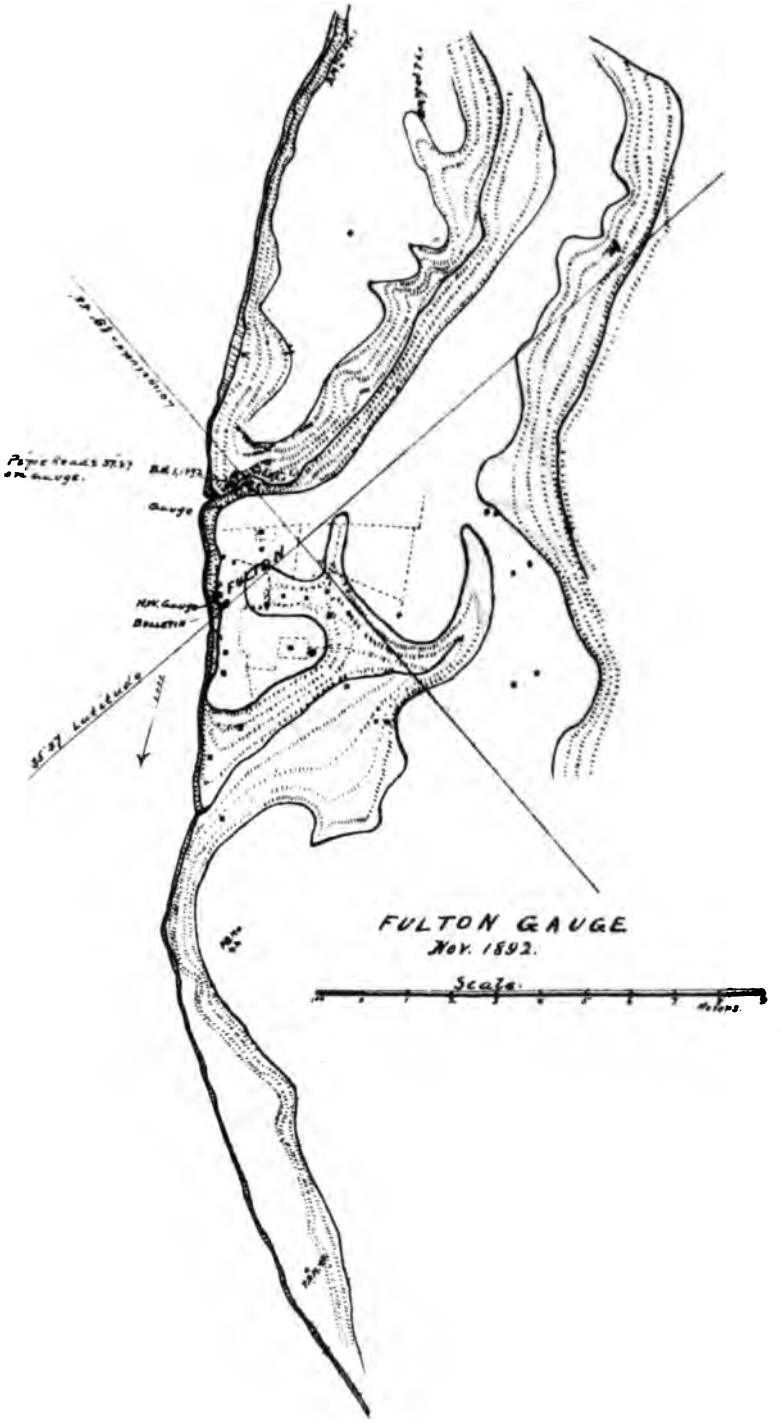


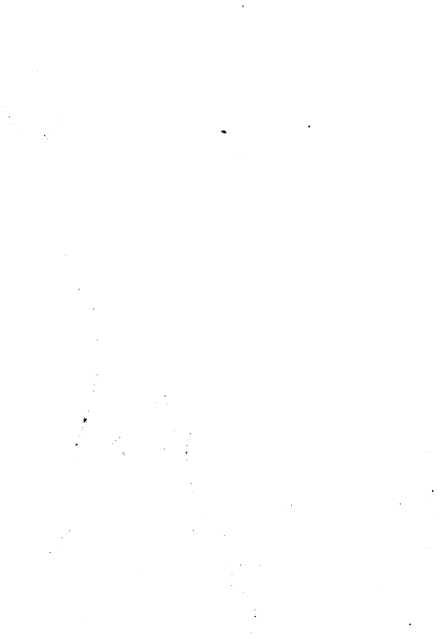

BELMONT GAUGE
NOV. 1892.
SCALE.
BELMONT ELEVATOR
COLUMBUS
60
BELMONT ELEVATOR
Conveyor Bridge
WARE HOUSE
DETAIL SKETCH

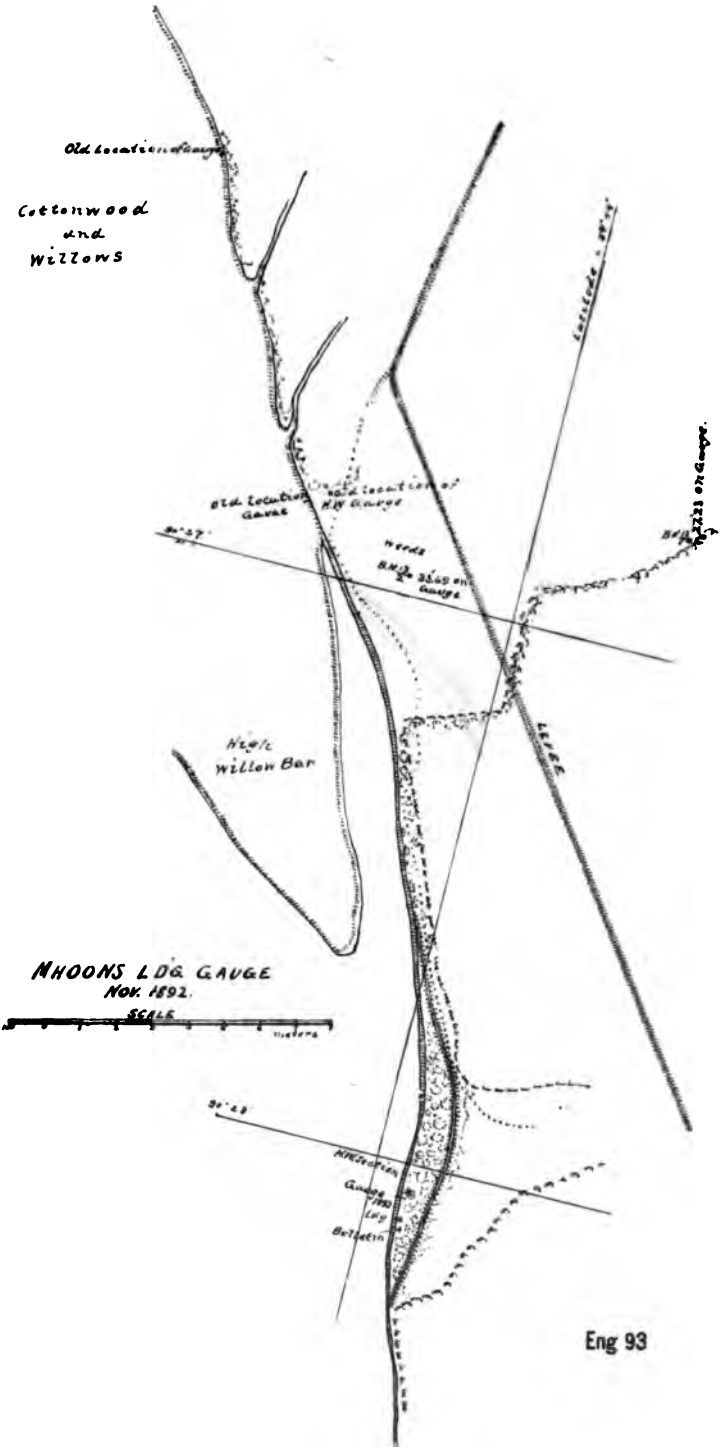

MORRISONS GAUGE
Nov. 1892.
Longitude = 89°30
Sand Bar
Scale of Meters
NEW MADRID GAUGE
Established Nov. 22, 1892.
ST JOHN BAYOU
BAYOU
Gauge
Gauge Outlet
Landing
NEW MADRID
Detail Sketch



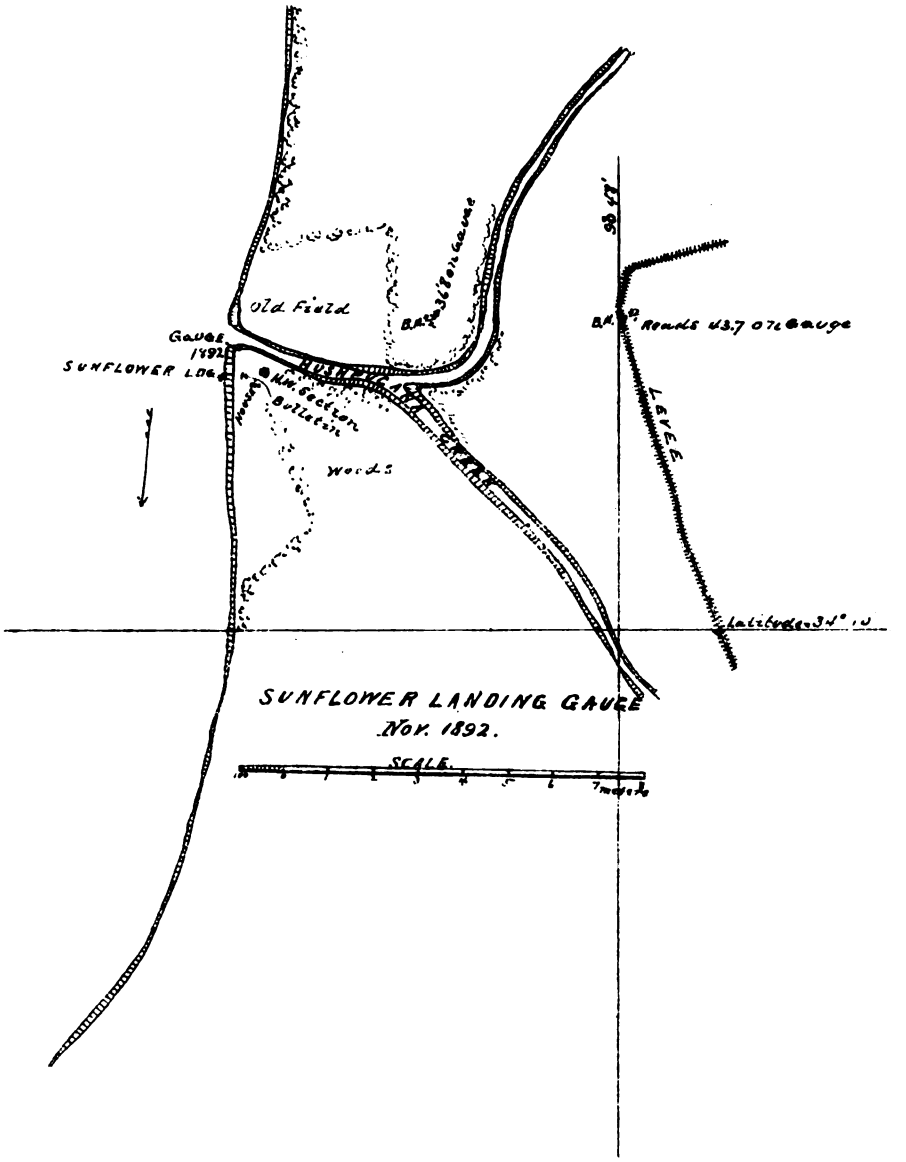

ISL. 18
NORTH BASE
Cottonwood Point
COTTONWOOD POINT GAUGE
Nov. 1892
Scale.
Landing
SOUTH BASE

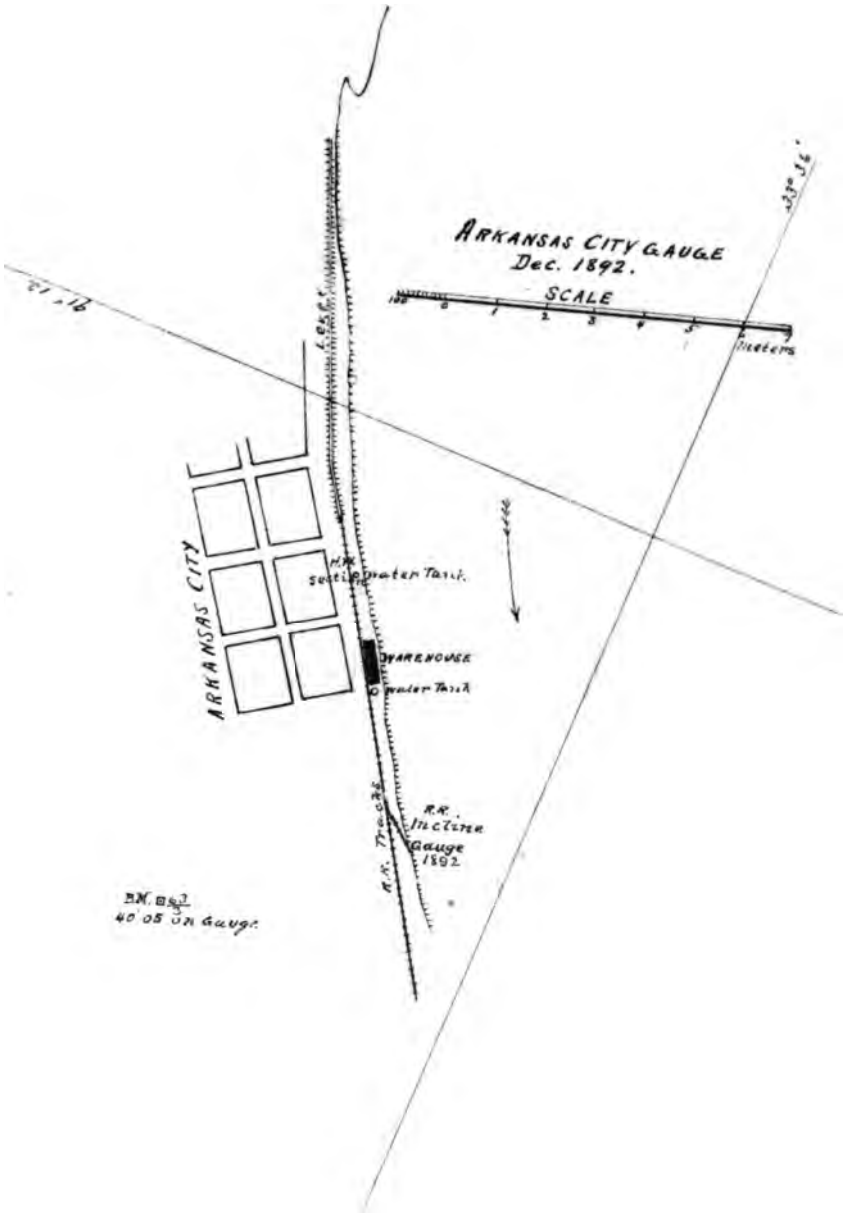

Gauge
Fulton
N.P.K. Gauge
Bulletin
FULTON GAUGE
Nov. 1892.
Scale.

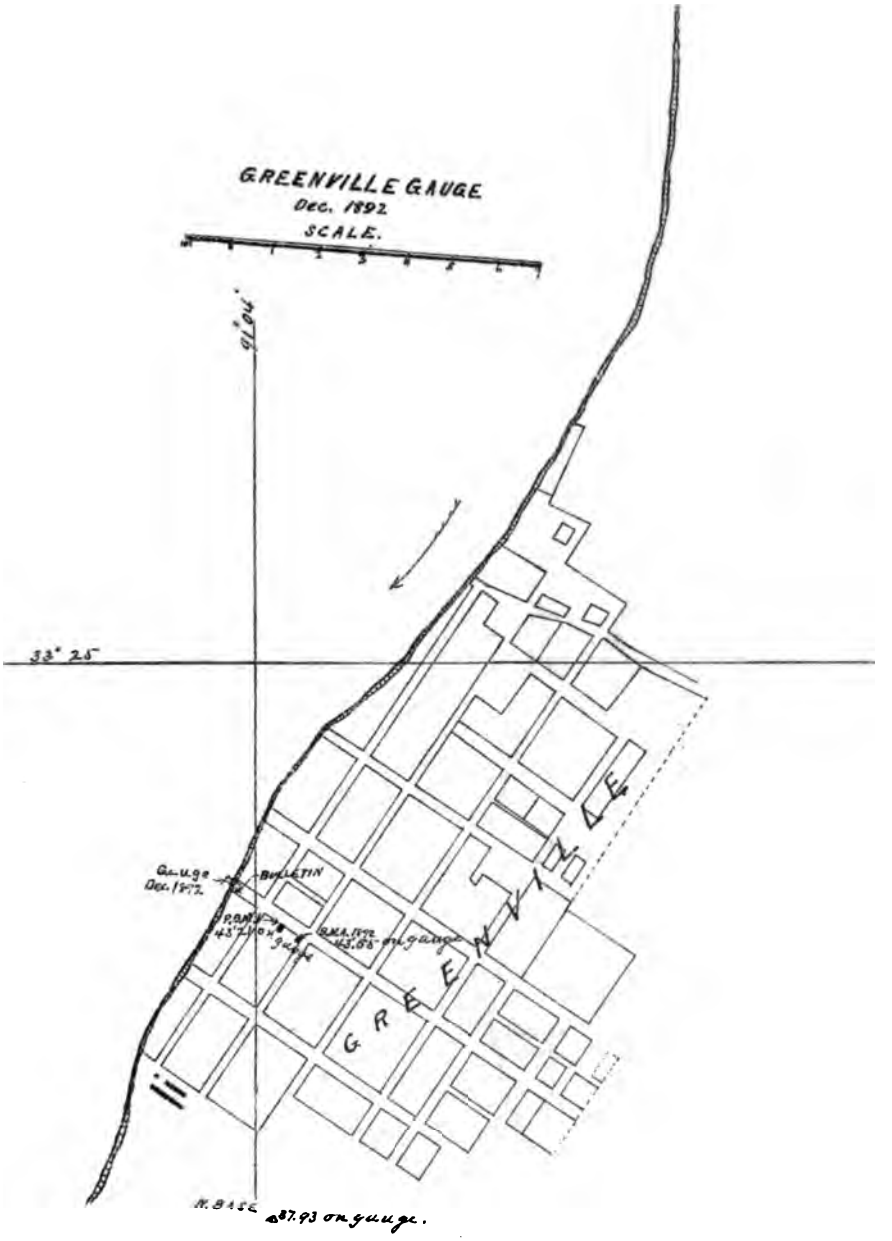


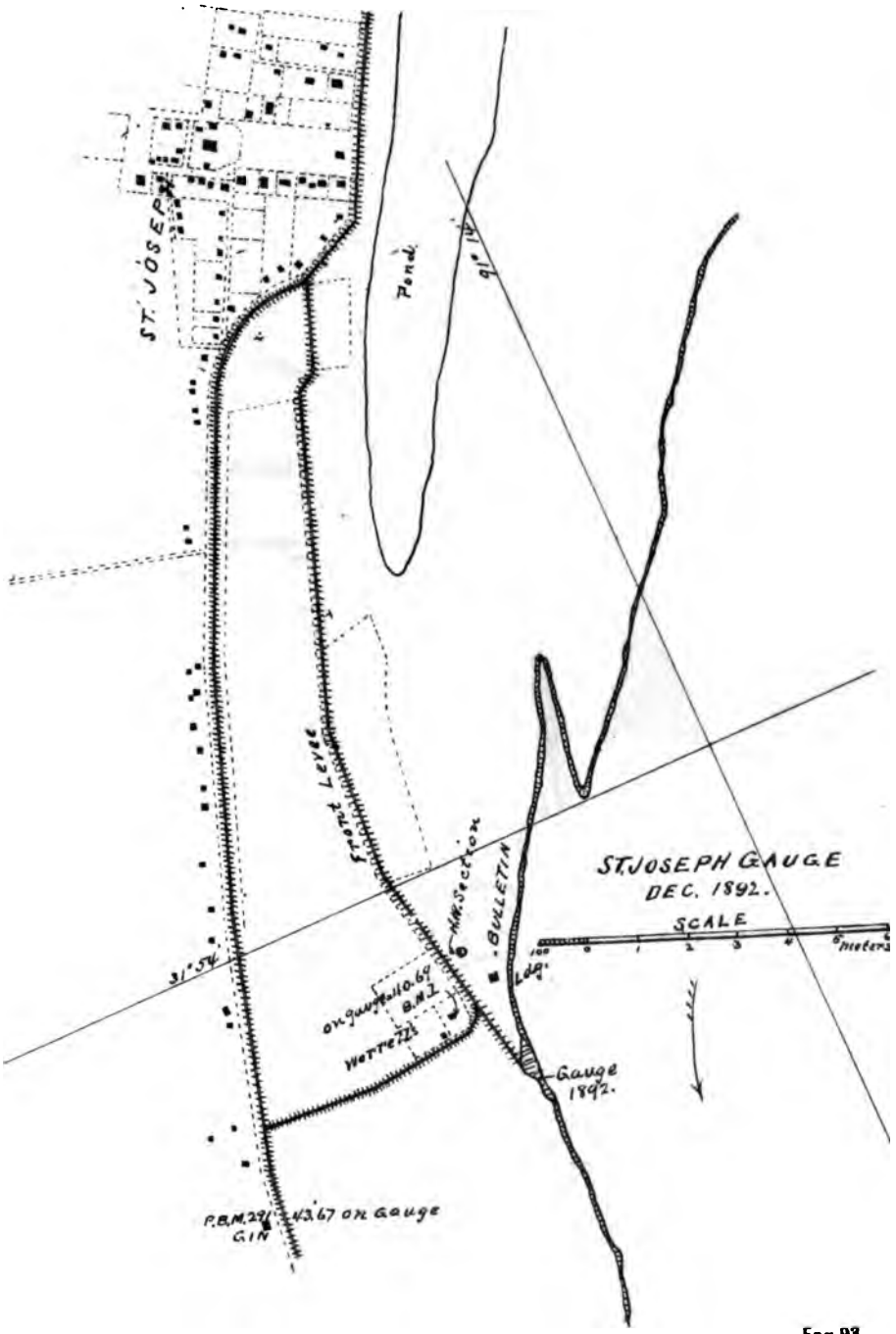

Old Location of Gauge
Cottonwood and Willows
Old Location Gauge
New Location of H.W. Gauge
Weeds
B.M. 25.49 on Gauge
High Willow Bar
NHOONS L.D.G. GAUGE
Nov. 1892.
SCALE
Meters
Gauge
Log
Bottom

Eng 93

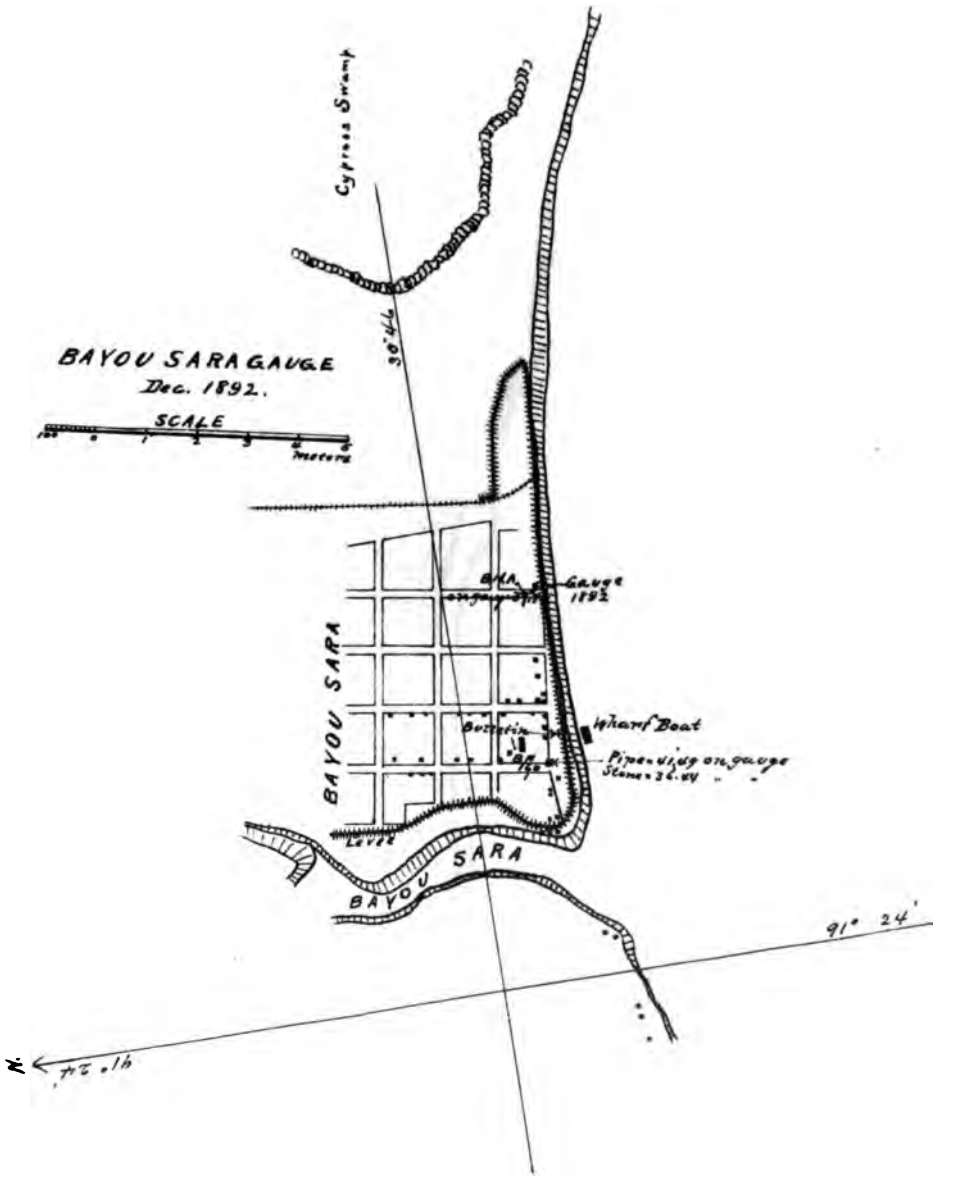

Old Field
Gauge 1892
SUNFLOWER LDG
Woods
Latitude 34° 10
SUNFLOWER LANDING GAUGE
NOV. 1892.
SCALE.

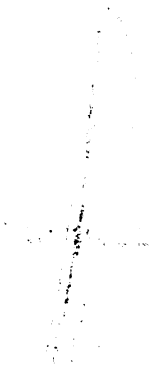

ARKANSAS CITY GAUGE
Dec. 1892.
SCALE
Feet
ARKANSAS CITY
R.R. Tracks
R.R. Incline Gauge 1892
B.M.
40 05 on Gauge

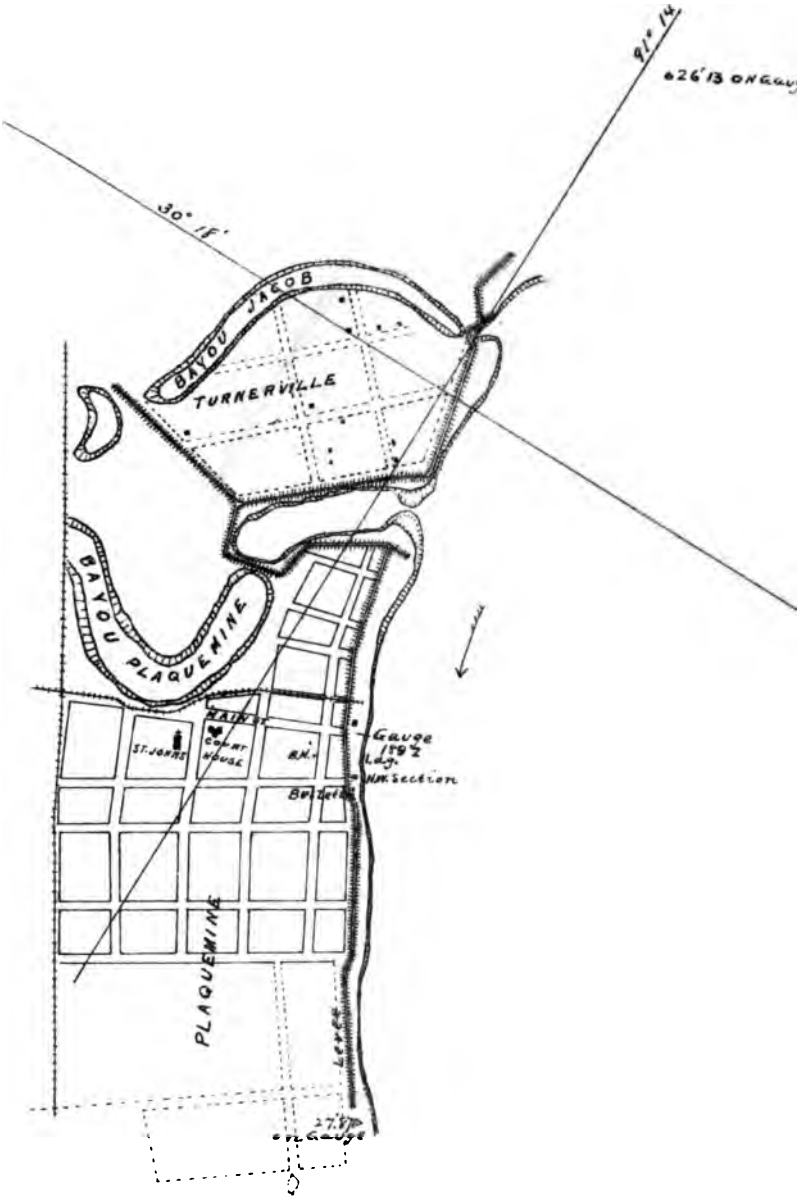

GREENVILLE GAUGE
Dec. 1892
SCALE.
91° 04'
33° 25'
Gauge Dec. 1892
BULLETIN
P.O.M.V. 43.71 on gauge
U.S.A. Tpg. 43.85 on gauge
GREENVILLE
M. BASE
87.93 on gauge.


ST. JOSEPH
Pond
91° 14'
FRONT LEVEE
HW. Section
BULLETIN
Ldg.
ST. JOSEPH GAUGE
DEC. 1892.
SCALE
100
0
1
2
3
4
Meters
31° 54'
on gauge 10.69
B.M. 2
Wharf 22
Gauge
1892.
P.B.M. 29
G.N.
43.67 on Gauge

Eng 93


BAYOU SARA GAUGE
Dec. 1892.
SCALE
Meters
Cypress Swamp
30° 46'
Gauge 1892
Wharf Boat
Pipe well on gauge
Stone
BAYOU SARA
Levee
BAYOU SARA
91° 24'
N
91° 24'

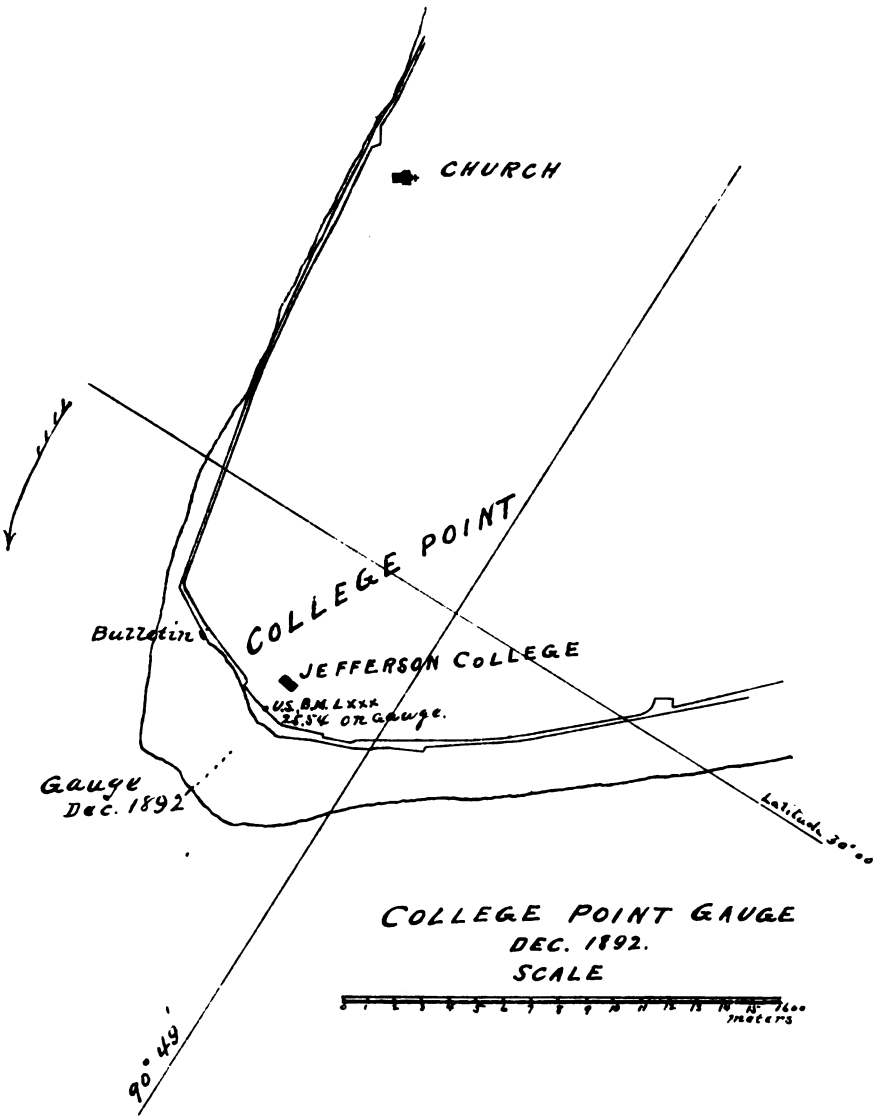




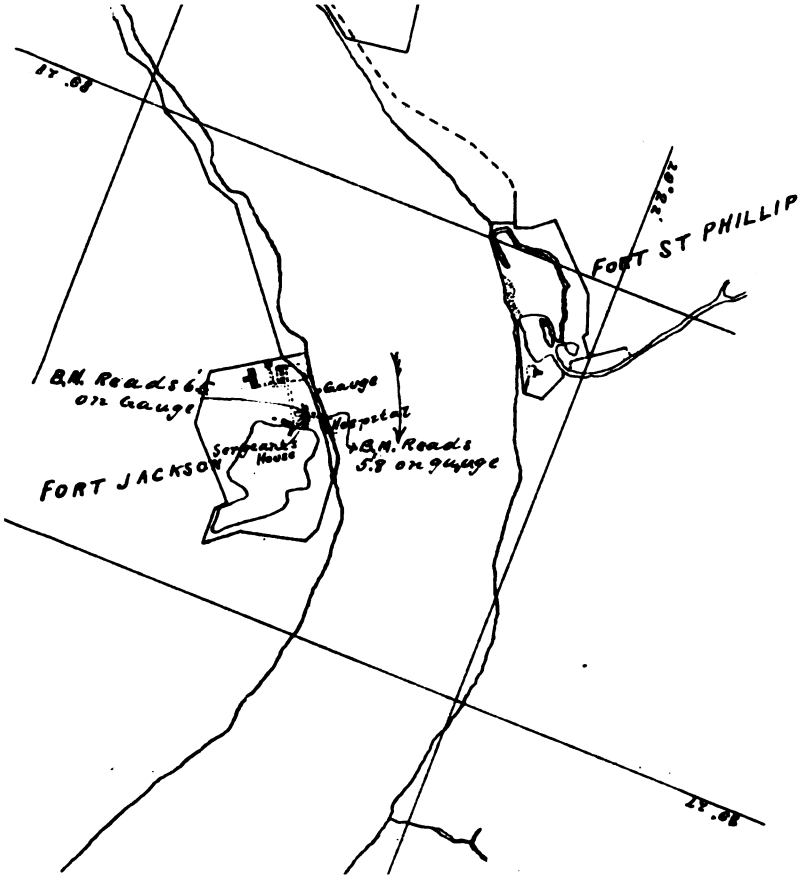
PLAQUEMINE GAUGE
DEC. 1892.

SCALE

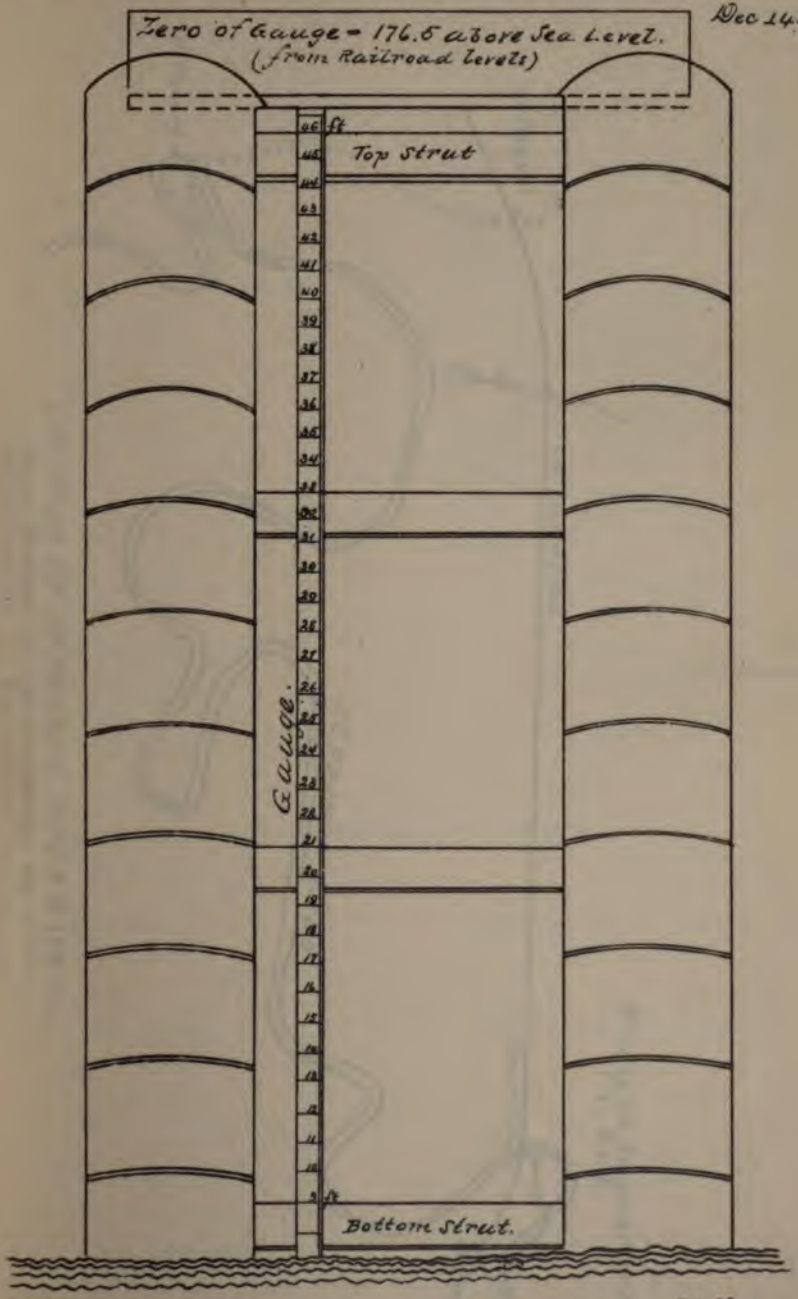
meters


CHURCH
COLLEGE POINT
Bulletin
JEFFERSON COLLEGE
U.S. B.M. LXXX
24.54 on Gauge.
Gauge
Dec. 1892
Latitude 38°-0
90° 49'
COLLEGE POINT GAUGE
DEC. 1892.
SCALE
meters

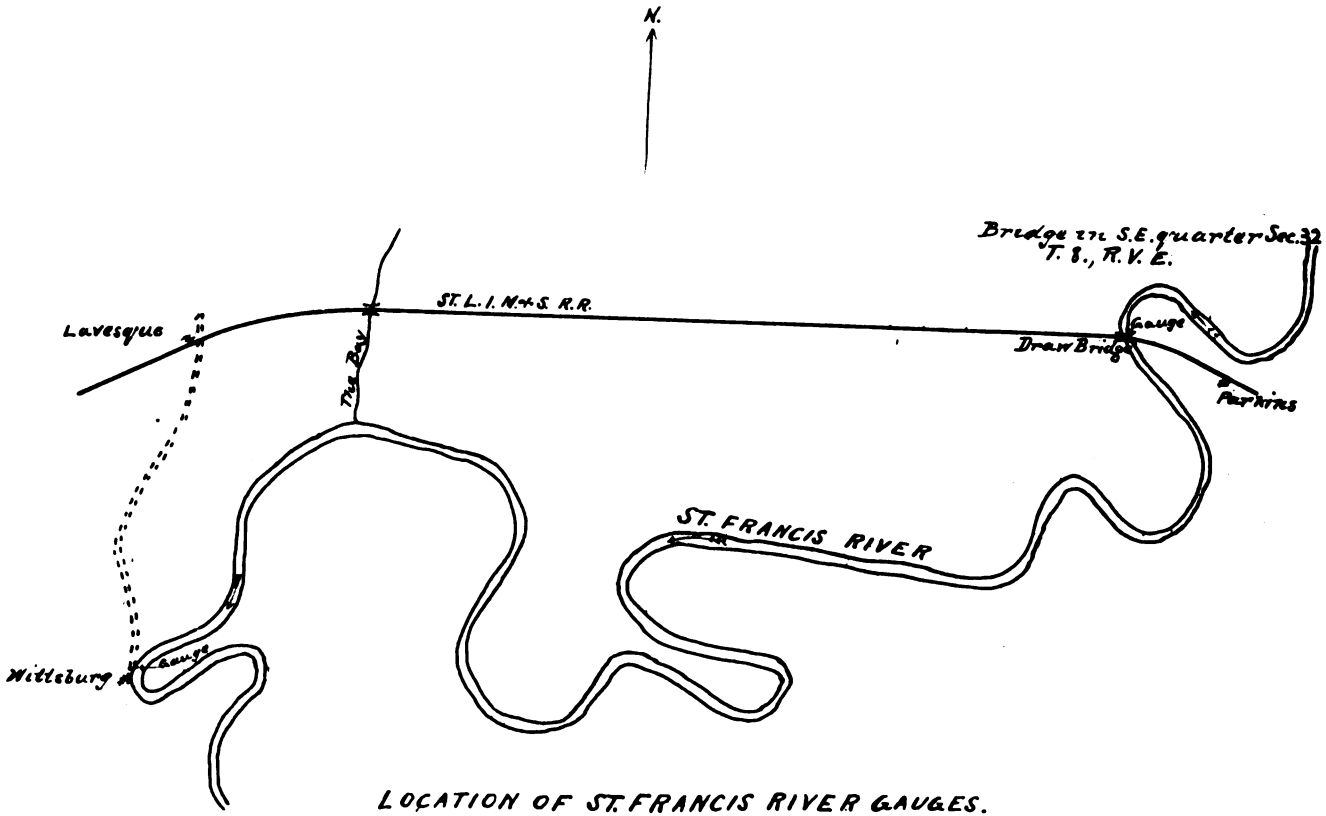
Eng 93


FORT ST PHILLIP
B.M. Reads 6.6 on Gauge
Gauge
Hospital
Sergeants Mess
FORT JACKSON
B.M. Reads 5.8 on gauge

East pier St Francis River Bridge Memphis Branch of St L. I.M. & S.R.R. Showing location of gauge established Dec 14. 1892.



Eng 93



LOCATION OF ST. FRANCIS RIVER GAUGES.

Draw Bridge Gauge Established Dec. 14, 1892.
Wittsburg Gauge Established June 29, 1884.
SCALE OF SKETCH, 1 in. = 1 mile.

APPENDIX 3 F.

Highest and lowest gauge-readings, 1898.

MISSISSIPPI RIVER.

[Gauge zeros are referred to Cairo datum plane, which is 21.26 feet below the (provisional) mean Gulf level.]

Zero elevation.	Station.	Stages.			
		Highest.		Lowest.	
		Date.	Gauge reading.	Date.	Gauge reading.
660.79	Hastings, Minn	May 26	13.1	Nov. 23	—0.70
660.34	Winona, Minn	May 26–7	12.1	Nov. 24	1.1
624.88	North McGregor, Iowa	May 31	15.8	Nov. 23	1.7
469.72	Hannibal, Mo	July 3	20.8	Dec. 21	—1.4
233.97	Grafton, Ills	May 18	215.85		
400.23	St. Louis, Mo	May 19	35.95	Dec. 24	1.1
*361.30	Chester, Ills	May 21	31.20	Jan. 15	—1.8
321.28	Grays Point, Mo	May 22	35.00	Dec. 29–30	1.85
287.14	Belmont, Mo	Apr. 28	43.14	Oct. 28–9	2.68
275.80	New Madrid, Mo (Morrissons Landing)	Apr. 29	†37.68	do	†3.4
250.62	Cottonwood Point, Mo	Apr. 30	36.45	Oct. 29–31	0.40
228.55	Fulton, Tenn	do	34.27	Oct. 30, Nov. 1.	4.72
203.97	Memphis, Tenn	May 2–3	34.60	Oct. 30–31	1.60
181.48	Mhoon Landing, Miss	May 8–11	36.30	Nov. 1–2	—2.2
161.98	Helena, Ark	May 11	45.73	Oct. 31	1.18
147.08	Sunflower Landing, Miss	May 11–13, June 1.	41.70	Nov. 1	3.2
128.73	Mouth White River, Ark	June 1	49.27	Oct. 27	6.50
116.44	Arkansas City, Ark	do	50.0	Oct. 28	2.1
108.00	Greenville, Miss	do	44.28	Oct. 27–28	2.80
89.62	Lake Providence, La	June 2	41.90	Oct. 28–29	0.70
66.04	Vicksburg, Miss	June 2–3	48.45	Oct. 30	—1.00
52.74	St. Joseph, La	June 3–4	44.55	Nov. 6–7	—2.00
36.89	Natchez, Miss	June 26	48.10	Oct. 29–31	5.00
*23.85	Red River Landing, La	June 27	48.87	Oct. 31	2.12
*23.95	Bayou Sara, La	June 28	42.25	do	—0.75
20.06	Baton Rouge, La	do	38.45	do	2.50
21.06	Plaquemine, La	June 13	33.50	Oct. 30	0.50
19.14	Donaldsonville, La	do	30.15	Nov. 9–10	2.30
21.24	College Point, La	do	25.62	Oct. 27 & Nov. 20.	0.25
20.91	Carrollton, La	June 10	17.35	Nov. 21	0.15
	Fort Jackson, La	June 13	†6.85	Nov. 20	0.50

* Approximate. † No record June 3–11.

TRIBUTARIES OF MISSISSIPPI RIVER AND ATCHAFALAYA.

	Arkansas River.				
241.55	Little Rock, Ark	May 21	31.20	Jan. 17	6.00
199.80	Pine Bluff, Ark	May 22	35.60	Oct. 17–18	7.85
	Atchafalaya River.				
24.17	Barbre Landing, La	June 27–28	49.70	Oct. 25	0.20
24.17	Simmsport, La	June 24	46.64		
20.17	West Melville, La	June 25	35.0	Oct. 26, 27	2.80
	Cumberland River.				
	Nashville, Tenn	Apr. 26	38.80	Nov. 1	—0.20
	Illinois River.				
*444.26	Beardstown, Ill	May 15, 16	18.4	Oct. 29–31	6.0
	Ohio River.				
447.58	Cincinnati, Ohio	Apr. 25	43.80	Nov. 5, 6	3.50
419.76	Louisville (upper), Ky	Apr. 23	21.80	Nov. 8	2.00
392.85	Louisville (lower), Ky	Apr. 23	47.40	Nov. 7	2.70
308.40	Paducah, Ky	Apr. 29	42 9	Oct. 30–Nov. 2.	0.7
290.84	Cairo, Ill	Apr. 28	48.29	Oct. 29	3.85

Highest and lowest gauge readings, 1892—Continued.

TRIBUTARIES OF MISSISSIPPI RIVER AND ATCHAFALAYA—Continued.

Zero elevation.	Station.	Stages. Highest. Date.	Highest. Gauge reading.	Lowest. Date.	Lowest. Gauge reading.
	Old River.				
24.17	Head of Turnbull Island, La	June 28	50.15		
	Ouachita River.				
96.69	Camden, Ark	June 6	37.10	Oct. 12–14	3.50
51.55	Monroe, La	June 27–29	41.1	Oct. 19	1.7
	Red River.				
244.78	Fulton, Ark	May 23, 24	34.85	Oct. 14	5.20
223.44	Garland, Ark	May 24, 25	28.40	...do	2.66
161.27	Shreveport, La	May 28	35.70	Oct. 13, 15	—2.00
64.46	Alexandria, La	June 12, 13	38.25	Oct. 20, 23	—0.65
	St. Francis River.				
	Wittsburg, Ark	May 9	39.4	Oct. 27–31 Nov. 10–14.	—3.60
	Tennessee River.				
*651.90	Chattanooga, Tenn	Jan. 17*	37.9	Oct. 26–Nov. 1.	1.1
	Florence, Ala	Apr. 8	24.00	Oct. 28–Nov. 2.	0.80
	Wabash River.				
*397.81	Mount Carmel, Ill	Apr. 13	21.5	Oct. 13–22.	0.6
	White River.				
	Jacksonport, Ark	May 20	30.40	Oct. 13–14.	0.80
	Clarendon, Ark	May 27–28.	32.65	Oct. 19–20.	6.45
	Yazoo River.				
93.92	Yazoo City, Miss	Apr. 29–30	27.40	Oct. 31	—1.00

*Approximate.

APPENDIX 3 G.

MISSISSIPPI RIVER, FROM CAIRO TO HEAD OF PASSES.

TABLE I.—*Showing for the years 1872–1892 (except as noted), highest and lowest and mean highest and mean lowest stages.*

[Gauge zeros are referred to Cairo datum plane which is 21.26 feet below the (provisional) mean Gulf level.]

Gauge zero.	Station.	Highest. Stage.	Highest. Date.	Lowest. Date.	Lowest. Stage.	Means. Highest.	Means. Lowest.
Feet.		*Feet.*			*Feet.*	*Feet.*	*Feet.*
290.84	Cairo	52.17	Feb. 27, 1883	Dec. 31, 1876	0.10	44.84	4.04
263.97	Memphis	35.60	Mar. 23–4, Apr. 4, 5, 1890.	Dec. 25, 1872	—0.95	32.88	2.09
161.98	Helena	48.10	Apr. 30, 1886	Jan. 5, 1888	—0.18	43.27	4.36
128.73	† Mouth White River	50.10	Mar. 31, 1890	Oct. 14–15, 1879	2.40	46.67	6.71
89.62	Lake Providence	41.90	June 2, 1892	Dec. 29, 1872	—3.85	37.23	2.72
66.04	‡ Vicksburg	49.05	Apr. 24, 25, 1890	Nov. 24, 1887	—3.91	43.70	2.89
36.89	Natchez	48.60	Apr. 23, 1890	Dec. 14, 15, 1872	0.00	42.99	4.54
23.85	* Red River Landing	48.87	June 27, 1892	Nov. 25, 1887	0.46	43.34	4.10
20.06	Baton Rouge	38.45	June 28, 1892	Jan. 9, 1877	0.90	32.47	2.89
20.91	Carrollton	17.35	June 10, 1892	Dec. 27, 1872	—1.60	13.72	—0.04

† High waters 1880–1892; low waters, 1879–1892.
‡ Low waters 1878–1879 interpolated from Lake Providence and Natchez.
*1879–1892 only.

APPENDIX 3 H.

MISSISSIPPI RIVER, FROM CAIRO TO HEAD OF PASSES.

TABLE II.—*Showing for the years 1872–1892 (except as noted) the mean number of days during which the stage in feet above extreme low water was embraced between the figures at heads of columns.*

[Gauge zeros are referred to Cairo datum plane, which is 21.26 feet below the (provisional) mean Gulf level.]

Gauge zero.	Extreme low water.	Station.	0 to 4.9	5 to 9.9	10 to 19.9	20 to 29.9	30 to 39.9	40 to 49.9	50 to 54.9
Feet.	*Feet.*		*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
290.84	[1]—1.00	Cairo	14.4	46.5	102.0	99.6	60.9	39.1	2.7
203.97	—0.95	Memphis	37.4	67.0	121.6	84.3	54.9	0	0
161.98	—0.18	Helena[2]	21.0	40.6	96.4	88.9	65.8	52.6	0
128.73	[3]0.0	Mouth White River[4]	5.2	32.4	83.5	84.4	69.9	89.2	0.7
89.62	—3.85	Lake Providence	6.0	42.5	97.9	86.4	94.2	38.2	0.0
66.04	—3.91	Vicksburg	12.3	25.5	82.4	71.6	70.9	90.0	12.8
36.89	0.0	Natchez	19.8	42.8	85.1	70.0	84.1	63.6	0
23.85	[5]0.0	Red River Landing[6]	32.2	41.1	81.9	65.2	90.6	54.4	0
20.06	0.90	Baton Rouge	67.2	59.1	76.7	117.3	45.0	0	0
20.91	—1.60	Carrollton	131.5	78.8	155.0	0	0	0	0

[1] December 24, 1871. [2] Except in 1879. [3] December 28, 1871.
[4] Except in 1872–'74 and 1878–'79. [5] December 15, 1872. [6] Except 1874 and 1878.

Small breaks in records interpolated from stations above and below.

APPENDIX 3 I.

TABULATED RESULTS, WITH FIELD AND OFFICE REPORTS, OF DISCHARGE MEASUREMENTS ON THE MISSISSIPPI RIVER AND TRIBUTARIES AND THE ATCHAFALAYA, AND OF CREVASSE AND OVERFLOW MEASUREMENTS, 1892.

Contents.

Name of station.	Reports.		Tabulated results.	
	Field.	Office.	Discharge.	Slope.
	Page.	*Page.*	*Page.*	*Page.*
St. Louis, Mo	.....	3675	3682	.....
Columbus, Ky	3664	3675	3682	3696
Fulton, Tenn	3664	3676	3683	3696
Helena, Ark	3664	3676	3684	3697
Chicot City, Ark	3669	3677	3685	.....
Arkansas City, Ark	3665	3677	3686	3697
Wilson Point, La	3669, 3672	3678	3688	3698
Natchez, Miss	.....	3679	3690	.....
Red River Landing, La	.....	3679	3691	3698
Simmsport, La	.....	3680	3692	.....
Carrollton, La	.....	3680	3693	.....
Little Rock, Ark	3673	3681	3694	3698
Monroe, La	3673	3681	3694	.....
Alexandria, La	3674	3681	3695	3699

Table of meter ratings on page 3700.

APPENDIX.

Page.

Crevasses Third District 3701
Bayou Bartholomew 3701
Crevasses Fourth District 3702

FIELD REPORTS.

EXTRACTS FROM REPORT OF MR. WILLIAM GERIG, CHIEF OF PARTY, UPON OBSERVATIONS AT COLUMBUS AND HELENA.

AMELIA, ARK., *August 9, 1892.*

I have the honor to make the following report on the high-water discharge observations made at Columbus, Ky., and Helena, Ark.:

The observations were made with the steamer *H. L. Abbot*, and the party of 9 men was subsisted on board. The meter method was used.

The instruments in use were Price meter No. 34, one register, one break-circuit sidereal chronometer No. 1344, made by T. S. & J. D. Negus, electric batteries, transit, level, sounding leads, lines, etc.

The meter was suspended from a boom 10 feet long at the stern of the *Abbot*, the boom projecting over the starboard side from the roof and making a right angle with the axis of the boat. A steel sash cord three-sixteenths of an inch in diameter passed around a reel on roof and near stern of boat through a small pulley in the end of the boom, thence to the meter. There was another steel sash cord which ran from the meter through a pulley on the end of a 20-foot boom, which extends over the bow of the boat, to a reel on the roof on bow of boat. By paying out proper lengths of standing and guy lines the meter could be immersed to any desired depth and held in place.

The observations of Columbus, Ky., were made on the same section that was used in 1891. The sounding and velocity stations were located with a sextant. The meter was lowered to the six-tenths depth.

The soundings on April 15 and 16 were made with a 60-pound lead attached to a steel piano wire, which passed around a reel on bow of the boat. The depth was obtained by counting the number of revolutions of the reel.

The observations were made in the usual manner. In deep water drifting soundings were made.

* * * * * * *

The gauge readings correspond to mean time of observation.

* * * * * * *

At Helena, Ark.—The section was the same as that used in 1888–'89. The methods of taking the observations were the same as at Columbus, Ky. The soundings on April 18 and May 3 were made with the 60-pound lead.

* * * * * * *

By referring to the accompanying table it will be noticed that after June 1 the velocities at Helena, Ark., have decreased very perceptibly. This was noticed at the time, and the meter was examined to see if there was anything wrong, and it was found to be in first-class condition. * * *

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

EXTRACTS FROM REPORT OF MR. A. F. KILPATRICK, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT FULTON, TENN.

MEMPHIS, TENN., *June 9, 1892.*

I have the honor to submit the following report on the field work of high-water-discharge observations at Fulton, Tenn., in April and May, 1892.

The party, consisting of assistant engineer, recorder, leadsman, pilot, mechanical engineer, fireman, and two deck hands, was organized April 13. The steamer *Itasca* and one skiff were used during the observations. Instruments in use consisted of two transits, one level, one stop watch, one 16-pound lead with ⅛ inch woven cotton line, and one set of double floats. A piano wire with 41-pound weight was also used to check soundings, but from awkward arrangement of reel and want of practice in its manipulations proved unsatisfactory.

The discharge section is located about 5,000 feet above Fulton, as indicated on the accompanying map*, which also shows position of gauges and surface velocity sections at Craighead Point and Falls Landing.

From a point above the steamer was allowed to drift to range B C, at which instant the sounding was made and signal given to transitman at D (see sketch*

*Not printed.

herewith), who noted the angle and color of signal flag, which latter and depth was recorded by assistant on board. In No. 1 and all odd soundings a red flag was used; a white flag was used in all even soundings. This system of flag signaling is highly recommended for this class of work.

Soundings were taken about 90 feet apart. The lead line used was very elastic, and although tape corrections were applied each day as soon as soundings were over apparent discrepancies are in great part due to it during the first week of observations.

In float observations the boat would occupy a position on an auxiliary range line above discharge station, and then be directed to the proper point on same by the transitman at D. The float was then dropped and closely followed by timekeeper in skiff, and when under good headway a signal was given to transitman at B and D, who observed and noted the "start" angles. At the expiration of one minute the signal was repeated and stop angles noted. Thus was determined the location, path, and time of each float. In the tabulated sheet herewith submitted the velocity normal to line B C at point of crossing or on prolongation of path of float is given. The object in view was to run the floats at certain places and have the anchor or submerged portion to travel mid depth the stream at each place.

The float consisted of a double-coned, air-tight tin buoy, with flag, connected by a fine cord with a tin anchor, which consisted of two sheets of tin 20 by 14 inches, crossed at right angles, making four leaves or flanges 7 by 20 inches. The buoy was 5½ inches diameter; total length, 12 inches. The connecting cord varied in length to suit depth of stream at each point used.

Of a number of surface floats passing through 200 feet ranges at Craighead Point and Falls Landing the velocity of the swiftest is reported.

Gauges were read daily and hour noted at Craighead Point, station "B," Falls Landing gauge, and at Fulton, and finally reduced to reading at time of discharge observations.

Levels carefully checked between gauges gave relative heights and data for calculating sin. of slope inclination.

* * * * * * *

The plan of discharge section, triangulation points, and paths of floats, etc., was platted on a scale of $\frac{1}{3000}$, as per tracings* herewith, and distances scaled and applied in arriving at results.

* * * * * * *

The river width was constant, the banks on each side being vertical during observations.

* * * * * * *

As the angle of slope inclination was exceedingly small the sin. was obtained by dividing the fall by the distance between two gauges and given to seven decimal places.

There are submitted herewith tracings showing discharge section, triangulation stations, and paths of floats each day, and cross-section sheets showing contour of bottom and velocity curves. The notes have been copied into one field book in ink, and all the plats and calculations carefully checked.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

EXTRACTS FROM REPORT OF MR. CHARLES H. MILLER, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT ARKANSAS CITY, ARK.

GREENVILLE, MISS., *July 19, 1892.*

The following is a report of the observation party stationed at Arkansas City Ark.:

The party, numbering thirteen, arrived at the station April 18, on board the U. S. snag boat *Florence*, which boat was used for the observations. Some of the old targets were found, and the range used last year was reëstablished, with the observing stations in practically the same places.

Velocity observations.—Price current meter No. 39 was used from April 22 until May 30, on which day old meter No. 5 was used; from May 31 until the end of the work, July 1, Price meter No. 38 was used.

The meter was attached to a rod holding a 230-pound lead weight, and lowered to six tenths of the depth on a three-eighth-inch wire cable. This apparatus about

* Not printed.

midway of the boat, to be near the center of gravity. A guy line of No. 12 wire, leading from the lead to the forward end of the boat, helped to steady and hold in place the weight. This line, after some experimenting, was finally attached to the upper end of 3-foot rod on which the lead hangs and meter is placed, instead of attaching it directly to the lead, which, it is thought, will cause much canting of the lead. To still further prevent the canting of the weight, and also to steady it, a sheet-iron vane, having both vertical and horizontal wings, was placed behind the weight.

For a recorder a telegraph sounder was used and the "ticks" counted. The usual time of occupying a station was five minutes, care being taken to begin and end on the discharge range, this being more carefully obtained by having a man in the pilot house assisting the pilot, one watching each range. This rule was observed universally, except where some extra work was being done.

Soundings.—Were taken with a 20-pound lead on a three-eighth-inch cotton line, located instrumentally by a transit at a point 2,000 feet above the range, reading the angle from the perpendicular. The flagman on the steamer being careful to always keep on the range by moving back and forth on the roof of the boat.

Meter ratings.—Ratings were taken as often as the time could be found. * * *

Double float observations.—Five of these observations were taken from time to time with the results as shown in the table.

The subsurface float was a tin cylinder about 15 inches high and 10 inches in diameter; the surface float was of tin in the usual shape of a buoy, about 10 inches long and 8 inches thick, these attached with fish cord.

Meter observations would be taken in the morning and the floats in the afternoon, using the same section which was sounded between the time of the observations. The subsurface floats put at six-tenths of the depth. Ranges set one 200 feet above and another 200 feet below the discharge range. The floats were dropped far enough above the upper range so as to acquire the velocity of the current and at a place so that they would strike near the respective stations. It was difficult to have them strike the proper place, and many were tried several times. Most times only one transit could be used. A skiff followed the float and signalled to the transit man when crossing the ranges; the skiff man keeping the time. The observation of July 1 was taken with two transits and therefore may be more nearly accurate than the others. It shows a marked increase in the floats over the meter, almost 4 per cent.

Drifting soundings.—Two sets of drifting soundings with piano wire were taken as a check on the lead line soundings. June 14 giving seven-tenths per cent less and June 21 giving 2¼ per cent less than the lead line.

Movement of boat.—Four observations were taken to determine the path of steamer during the time of occupying a station; observations taken every thirty seconds. When possible these were taken with two transits on the bank reading simultaneously at a signal from the boat, angles to a fixed flag on the roof of the steamer. But when only one transit was used it read the angle to the flag to determine the lateral motion, while the movement above or below the range was observed from the boat at the same time by having the railing graduated in feet both ways from the flag (or zero) and a man to move back and forth, constantly remaining on the range and recording his position at the proper moment.

The observation of May 5 being incomplete no calculations were made for that day, but the corrections for the other days are: May 14, subtract 11,781 cubic feet; May 30, subtract 2,410 cubic feet; June 3, subtract 880 cubic feet.

It will be observed that the large amount on May 14 is due mainly to the fact that on two of the stations the observations ended at a considerable distance above the place of starting. This, because of a necessarily different distribution of the force, there being no one to assist the pilot; hence the results are much in excess of what they would be under the usual distribution of the force, and show that the movement of the boat introduces little or no error.

Direction of current.—This can be observed from the path of the floats shown on the tracing, and it will be seen that there is almost always some angle with the perpendicular to the range. It is believed, however, that any error from this source is very small and should not be considered.

Panther Forest Crevasse.—Occurred May 13, 11:30 p. m., at a point about 3 miles below Gaines Landing, and 450 miles by channel distance from Cairo. (For results see crevasse table).

Fulton Lake Crevasse.—Occurred June 2 about 1 mile below Arkansas City and 438 miles by channel distance below Cairo. At first a series of small breaks a foot or so in depth running through the railroad.

The observations from June 3 to 15, inclusive, were taken by Mr. Baily who had charge of the party during that time; those of the 27, 28, and 29 of June were also taken by Mr. Baily (with his party and outfit).

REPORT OF MR. E. C. TOLLINGER, CHIEF OF PARTY, UPON OVERFLOW BETWEEN ARKANSAS CITY AND TRIPPE.

ARKANSAS CITY, ARK., *June 25, 1892.*

I have the honor to submit the following report upon the discharge observations between Arkansas City and Trippe, May 28 to 31, 1892.

The nature of the openings.—The discharge was through two kinds of openings. The one was under pile bridges with the surface of the water about 3 inches above the top of the stringers, and the other was over the railroad embankment and track.

Methods employed.—The first series of discharge observations was taken with surface floats, the points of observation being generally from 25 feet to 50 feet below the railroad.

It was feared that the indicated surface velocity below the bridges was too small on account of the obstruction of the current at the surface, by the stringers, and too great below the embankment, on account of the tendency of the surface water to flow over the lower strata behind the embankment. In the second series weighted rods from 5 to 10 feet long were therefore used for floats below the bridges, but on account of the bushes under the water [in other locality], tin surface floats were used, the same as in the first series of observations.

On account of the rods not nearly reaching the bottom of the water, eight-tenths of the observed velocities was taken as the mean of the vertical, the same as for surface floats. (See tabulated results).

In comparing the two sets of observations it will be observed that the velocities average about the same, but that in ganging the flow over the embankment a considerable portion was ganged in the first set of observations, that was omitted as unimportant in the second set, otherwise the results would have been more nearly equal.

Testing the relation of mean vertical velocities to surface velocities.—Noting the difference between the results of the discharge observations in 1890 and 1892, some observations were made, June 14 to 16, with Price current meter No. 5 to ascertain to what extent the relation of the mean vertical velocity to the surface velocity, was modified by the above-mentioned conditions.

In these observations the mean vertical velocities were generally obtained by differentiation, that is, by noting the velocities indicated by the meter while passing slowly from the surface to the bottom and return.

The results of these test observations are appended, and show that in the observations below the embankment, the mean vertical velocity was 56 instead of 80 per cent of the surface velocity, and below the bridges, 108 instead of 80 per cent.

Substituting these ratios for 80 per cent in the computations would change the results as follows:

Observations of May 28 and 29: $\frac{56}{80}$ of 188 = 132 (approximately); $\frac{108}{80}$ of 121 = 163 (approximately); 295 (approximately) thousand cubic feet per second.

Observations of May 30 and 31: $\frac{56}{80}$ of 121 = 85 (approximately); $\frac{108}{80}$ of 140 = 189 (approximately); 274 (approximately) thousand cubic feet per second.

When these test observations were made the surface of the water was very little above the bottom of the stringers, whereas at the time the discharge observations were made it was about 3 inches above the top of the stringers.

Again, the observations of series 2 of the test observations were not made as far from the embankment as in the regular discharge observations and hence the influence of the disturbing element is magnified in the test.

These considerations would indicate that in each case the discharge was somewhat greater than the above substitution of ratios would show.

Comparison of discharges in 1890 and 1892.—The maximum discharge in 1890 was only about 149,000 cubic feet per second, or about one-half as great as in 1892.

In 1890 this overflow was principally from crevasses in the levees along the Mississippi River south of Amos Bayou. In 1892 there were no crevasses in these levees, but several in the levees along the Arkansas River. Of these the Auburn Crevasse was 1¼ miles long and the Sarassa 1 mile long. The river was 3.6 feet higher (at Little Rock) in 1892 than in 1890.

These crevasses not only had a large sectional area, but were so located that parts of them were in line with the direction of the current immediately above, giving the discharge a high velocity, and being about 35 miles above the back water from the Mississippi River and 100 miles by river from the locality of our discharge observations, while only 35 miles distant by the route through the crevasse, the resulting slope was much greater than that of the overflow of 1890.

Effect of the high stage of the Mississippi River.—The crevasse being about 60 miles from the mouth of the river and about 35 miles above the back water from the Mississippi River I infer that the discharge would have been about as great had the Mississippi River been several feet lower than the stage reached by this flood.

* * * * * * *

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

REPORT OF MR. E. C. TOLLINGER, ASSISTANT ENGINEER, UPON DISCHARGE OF BAYOU BARTHOLOMEW, WITH LETTER OF MR. HOWARD DOBB, OBSERVER.

ARKANSAS CITY, ARK., *July 2, 1892.*

I would respectfully state that the discharge observations of Bayou Bartholomew were taken at Browns Bridge, Lincoln County, Ark. This location was more favorable than at any point below for obtaining satisfactory results. The water in the bayou had fallen 4 feet when the observations were taken, and it is reasonable to presume that a greater surface velocity would have been obtained at the maximum rise, but as the water had been over one part and against the stringers of the remaining part, and as the bridge did not show any signs of being moved from its foundation it is my opinion that the maximum velocities were but little if any greater than at the time the observations were taken.

The bayou is through a low flat country, and above the Lincoln County line. The bed of the bayou is occupied with a growth of large cypress trees giving it the appearance of a large cypress brake.

"ARKANSAS CITY, ARK., *June 29, 1892.*

"In connection with report, herewith returned, of observations taken on discharge of Arkansas River flood into Bayou Bartholomew, I wish to state that owing to the fact that the water had fallen 4 feet from its maximum height before observations were made, accuracy in obtaining correct soundings and measurements was difficult. Only three openings were found at that time emptying into Bayou Bartholomew—*i. e.*, Fletcher Brake, Deep Bayou, and Ambon Bayou. The actual width of these was taken by measurement, 4 feet added to soundings for depth, while the additional width allowed for added height could not be accurately ascertained, but was estimated as nearly as possible, from marks left by the water. In all these streams the velocity was taken by surface floats, and after repeated trials was found to be 1 foot per second, and having one week before taken observations on Ambon Bayou and Fish Deadening, when the flood was at its greatest height, and found the velocity to be the same as at this date, that figure was taken for the correct velocity. The remaining points of discharge, six openings into Fletcher Brake, Browns Bayou, The Wash, north of Deep Bayou, and Fish Deadening were dry, and no observations could be taken further than estimates from measurements of the depth and width as shown by the marks left on the trees and banks, by the overflow; and the velocity, all else being equal, was considered at the same rate with the streams taken, and with Fish Deadening as formerly taken at the greatest height of flood.

"In order to have proof of the correctness of observations made, I took soundings, etc., of Bayou Bartholomew at a bridge crossing just below the confluence of Deep Bayou, where it carried off the water from Deep Bayou, the Wash designated, Fish Deadening, and Ambon Bayou, and return figures in my report. The velocity here was tested thoroughly and showed only 1 foot per second with surface floats. The sluggish current in this stream I attribute to several causes, being that it is a long and extremely crooked stream, draining an even and almost level swamp, having virtually two channels, or rather having the low-water channel in the center of a depression extending 50 yards on each side of the banks, before reaching the general level of the swamp. The channel proper will average from 100 to 120 feet wide and 3 feet deep, which carries all drainage, except in rainy seasons. The depression referred to extends the whole length of the stream and is filled with a thick growth of vines and timber, and retards the current to such an extent that there is little difference in its velocity at different stages, and for the velocity of the streams and inlets found emptying into it I am satisfied that no greater rate existed, from the fact that owing to excessive rains prevailing during the flood, the water in Bayou Bartholomew was at or near a level with the water in the swamps; and more current existed during the first rise and subsequent fall of the overflow than at the time when both were at their greatest height. This fact was illustrated in the case of Fletcher Brake. The brake or lake was a circular body of water 100 yards wide and 4 or 5 miles long, emptying into it its full width. This lake was fed by a bayou about 200 feet wide and six small washes leading from the overflow, and yet no current was perceptible at its mouth, where both currents met, and dead water was the consequence. This could not have been in case of protracted flood, but it having existed only four or five days, the water from all sources only served to fill the lake, and it could only find egress as the bayou fell."

EXTRACTS FROM REPORT OF MR. T. C. J. BAILY, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT WILSON POINT AND CHICOT CITY.

GREENVILLE, MISS., *July 22, 1892.*

The following report on discharge observations taken by me during the high water of 1892 is respectfully submitted:

On April 11 the survey steamer *Meter*, with quarterboat and a party of thirteen, left for observations in Lake Providence Reach.

From the 16th of the month until June 20 continuous gangings were taken, except on a few days when storms prevented.

Party.—The party consisted of a chief, two assistants, pilot, engineer, leadsman, and crew, in all thirteen souls.

Section.—A discharge section was set up just above Wilson Point Landing, it being the same that was used for high and low water observations taken last year. The river here is 3,842 feet broad between banks, but during the entire series of gangings the water was over the Louisiana bank against an old levee, which is 80 feet back. The velocity in this 80 feet was so uniform that no separate measurements for it were made, it being included in the last partial discharge.

Profiles of shore and section of levee were run, stakes being driven every 10 feet out to the bank line, so that the water width at any date could be accurately determined. From April 16 to April 29 this width increased from 3,925 to 3,946 feet; after the 29th, and until the end of the series, the water was against the nearly vertical side of the old levee and its width remained constant at 3,946 feet. The meter stations were placed 300 feet apart, No. 1 being 42 feet from the Mississippi bank and No. 13 190 feet out from the Louisiana side.

Halfway across the section a pivot 1,000 feet above and radial targets on the nearest bank were used; for the remaining half all the targets were on the opposite bank. This gave for the smallest intersection 27° 31′. Two thousand feet above the range on the Mississippi side the Duncansby Chute pours an immense volume of water into the river at a high velocity, the axis of the chute forming an angle of 39 degrees with that of the river at the point of entrance. It is believed that this water, by eating out the bar which has formerly existed at the east end of the section, is one of the causes of the great variations which may be observed from day to day in the discharges. Stations 2, 3, and 4 were the ones affected, the current varying on them so greatly from minute to minute that it was extremely difficult to judge when a true average velocity had been obtained. For this reason these stations were occupied from ten to twenty minutes, and, in fact, all the stations were occupied for an average time of eight minutes, no fixed period being used, the counting beginning and ending on range and continuing until, in the judgment of the chief, a fair mean velocity had been obtained. From June 6 until the end the current on Station 1 was running upstream as determined by double floats, and the entire partial discharge of this section thereafter was subtracted from the sum of the remaining partial discharges. The position of the seam between the up and downstream currents was not at all constant, it shifting from a point 50 feet outside Station 1 to Station 2 within a minute. These circumstances rendered it difficult to obtain a true discharge during the highest stages of the river.

Methods of procedure.—Until May 30 Price meter No. 38 was used at this station; from that date until the end of the series No. 39 took its place, No. 38 being sent to Arkansas City. The meter was attached to a rod 18 inches above a 225-pound lead, and submerged to six-tenths the depth by a reel worked with a system of spur wheels so arranged that one revolution of the crank would lower the meter 1 foot. A stout wire was attached at first to the weight, afterward to the swivel in the rod above the meter, and ran forward over a cleat in the bow of the steamboat to another reel. The proper length of this guy line to pay out in order that the weight should be under its reel was obtained by means of a table prepared for the purpose. No vane was used on the weight, but my experience while in charge of the party at Arkansas City (where an 18-inch iron one was used) has demonstrated the fact that the meter is much steadier in the water and the lowering wire much nearer vertical with the vane than without it. The revolutions of the meter wheel were counted on an ordinary telegraph sounder in a circuit with from three to four Leclanche cells.

The chief of the party personally supervised the working of the steamer, all arrangements of the meter, and at times checked the countings of the assistant. He also gave the signal when to start and when to end counting, recording the revolutions per minute and motion of boat with reference to the current, and judging when a mean velocity had been registered. The average time used in measuring velocity was three hours.

After using the meter, soundings were taken at irregular intervals across the section using a 20-pound lead on a three-eighths inch cotton line, each sounding being located by a transit angle from a point 1,700 feet above the section. The chief remained on the steamer and checked every reading of the leadsman, taking care

that the soundings were caught on a vertical line. After the soundings were taken the lead line was tested, and in case of a line which changed much tests were made both before and after running over the section, each set of corrections being applied for half way across. In order to test the accuracy of this method drifting soundings were taken. A 20-pound lead was attached to fine steel wire graduated every foot with solder and tagged every 5 and 10 feet; this was paid off from a reel. The weight being lowered to within a few feet of the bottom, the steamer would drift down; when near the section the flagman would raise his flag as a warning to the transit man and also give warning signal to the man manipulating the brake. At the instant of crossing range flagman would call time and drop his flag, while the lead would be allowed to run down until it touched the bottom when the depth was read. The results will be found in the table of discharges:

June 10, mean depth—	Feet.
By ordinary method	61.9
By drifting	60.5

As this is the first trial of the method it is believed that errors were made in reading some of the depths, the graduation being very fine and difficult to read.

[NOTE.—At Arkansas City I used a register devised by Mr. John S. Dodge, a member of the party. It consisted of a pointer revolving around a dial graduated for every foot and connected by a train of wheels with the axle of the lowering wheel. It was arranged to read zero when the bottom of the lead touched the surface of the water and graduated by paying out every 5 feet of wire off the reel, marking the dial opposite the arm and dividing the spaces between into five equal parts. The appliance worked very satisfactorily for checking the readings of the leadsman, and would indicate correct depths to the nearest half foot.]

June 17, mean depth—	Feet.
By ordinary method	60.0
By drifting	59.6

A very close agreement.

All gauges were read to the nearest hundredth before and after each velocity observation.

Float observations.—In order to test the discharge measurements with the meter, four observations with double floats were taken. The meter was run in the morning, soundings taken, and floats in the afternoon, using the same water area for both. Ranges parallel to and 250 feet above and below the discharge section were set up and two transits used for locating the floats, one being on the levee in the discharge range the other at △ Ruple 1,770 feet above. The surface floats consisted of two tin cones, 7 inches in diameter at base and 6 inches high, placed base to base. The subsurface float consisted of a tin cylinder 12 inches high and 10 inches in diameter, having a strip of lead around the bottom and sixteen air chambers, half cylinders 4 inches high, 1¼ inches diameter around the top. The float was submerged to six-tenths depth, as determined by the soundings taken in the morning.

The object being to so place the float that it would cross the discharge range on or near the meter stations, the steamer, towing a skiff, would move up to the section, flank over until on the required station, then run upstream parallel to the current. When a sufficient distance above the upper range the skiff would cast loose, float placed in the water, and skiff remain near and opposite to it. When close to the upper range a flagman in the boat would raise his flag, which would be dropped in crossing the range, time noted, and the two transit angles read.

This programme would be repeated for the other two ranges, after which the steamer, which had drifted down, would pick up the skiff and proceed to the next station.

* * * * * * *

The results of these observations may be found in the tabulated statement of discharge and will be seen to agree closely in every case with the meter work.

*Motion of steamer while on stations.**—There appears to have been some doubts as to the accuracy of the present method of meter observations, due to the lateral and normal motion of the boat. To discover what effect this motion would have, three sets of observations were made to determine the path of the boat, the method of procedure being as follows: Two transits were placed, at △ Ruple, the other at △ Harris, both above the section on opposite sides of the river transits being set in azimuth by sights on the opposite stations. A piece of white cloth was placed on the starboard steam pipe nearly above the meter and simultaneous azimuths read

*Discussion of error due to lateral motion of boat and formula for correction given in report on reduction in secretary's office of Arkansas City discharges of 1884–'85. See Report Chief of Engineers, 1887, p. 2836.

every minute on this mark, the chief on the steamer counting and signaling at the proper times. At first these azimuths were taken every thirty seconds, but it was found that nearly all the motion could be obtained by minute intervals. One set was taken in a light wind and the other two in a strong one, from the most unfavorable quarters parallel to the section; the azimuths were then plotted to a scale of 125 feet to 1 inch, and the course of the boat traced.

When the steamer is sliding along parallel to the section, that is, perpendicular to the current, the meter is measuring the resultant of its motion and that of the current; in other words the hypothenuse of a right triangle whose base is the side velocity of the boat in feet per second, and whose perpendicular is the velocity of the current in feet per second. If the movement is upstream parallel to the current, the sum of the current's and boat's motion is registered; if downstream, the difference.

Let l denote the sum of all the components of the boat's motion on a station parallel to the section.

s = distance between the initial and final position, at the end of an observation on one station, measured normal to the section.

t = time in seconds that the station is occupied.

V = velocity registered by the meter.

v = true velocity.

c = correction to be applied to V in order to obtain v.

Then: $c = \frac{l^2}{2t^2 V} \pm \frac{s}{t}$, the second term being minus when the steamer ends above and plus when it ends below the initial point.

Using the formula given above, corrections were made to the discharge obtained on these days, as indicated in the table. The observations showed that the first term, even on the windiest day, is very small, both quantitively and relatively to the second term, and that, with proper care an error less than one-half per cent is introduced into the discharge.

Meter ratings.—During the time that meter No. 38 was in use at Wilson's Point, that is, from April 16 until May 30, four ratings were obtained, one in Old River, Louisiana, taken from the steamboat along a 1,600-foot base, meter submerged 15 feet, and three at Wilsons Point, taken from a skiff along a 400-foot base, meter submerged 4 feet in 10 feet of water.

* * * * * * *

The rate of meter No. 38 while in use at Wilsons Point remained constant. Meter No. 39 was rated once at Wilsons Point and once near Greenville. The results were identical with those found at Arkansas City.

* * * * * * *

On July 5, meters Nos. 38 and 39 were rated in a borrow pit along the railroad at Sunnyside Landing, Arkansas. The water was but 6 feet deep and the pit narrow. It was found that the rates of both had changed on the same side, but as observations of July 11 in the deep water of a chute opposite Greenville did not indicate this change it was decided that owing to the shallowness and narrowness of the pit at Sunnyside the displaced water did not have free play. The results were therefore not used in the reductions.

Bank discharge.—Was measured on the Mississippi side alone, that on the west side, as before stated, being included in the river discharge. The range was above the discharge section, and about half a mile back from the river, at the intersection of the main levee with the one running out to the Lower Skipwith's Landing. The meter was held just beneath the surface, a reduction factor of nine-tenths being used to reduce surface to mean velocity. Owing to the heavy growth of timber and underbrush through which water was running it was impossible to measure all the water flowing over the banks, but it is believed that three-fourths of the total amount was obtained.

Crevasse measurements.—Brooks' Mills Crevasse, 505½ R., occurred at 5:30 a. m. May 9. Three measurements for discharge were taken, one by Mr. George C. Thomas, one by Mr. Charles Miller, and one by myself.

Leland Crevasse, 484½ R., occurred May 25. It was measured by me three times.

Crevasse below Columbia, Ark., 470 R., occurred June 22. It was measured by me once. The results of these measurements are found in the accompanying crevasse table.

Chicot City discharge section.—On June 27, Mr. Charles H. Miller, in charge of the Arkansas City party, set up a discharge range 2,300 feet below Chicot City Landing, and 6¼ miles by channel above the Arkansas City discharge section. The river here is 3,962 feet broad between banks. Fourteen meter stations were located 300 feet apart, Station 14 being 90 feet from the Mississippi bank line, and Station 1, 70 feet from the Arkansas shore. The section was shallow and the velocity observed on stations extremely variable. On June 28 and 29 Mr. Miller measured discharge here

Soundings and velocities were taken at irregular intervals across the river, the velocities being generally less than 200 feet apart.

Cross sections were plotted to a scale of 1 inch = 200 feet horizontal and 1 inch = 20 feet vertical, and on these the velocity curve was plotted in registrations of the meter per second.

Soundings were scaled from these, 100 feet apart, and velocities generally 200 feet apart, for computing discharges.

The end areas were computed precisely from the notes. The end velocity station on shallow side was generally about 200 feet from shore, and on the deep side was from 26 feet to 164 feet from shore.

The meter was not rated during the season, hence the rating of September 23, 1891, was used; the equation is $y = 3.7895\ x + .212$.

The time during which meter was run at each station varied from 70 to 294 seconds, but was generally about 160 seconds.

Datum line was taken same as last season, at 40.55 feet on the standard M. R. C. gauge at Belmont, Mo.,* whose zero is 287.14 feet above the Cairo datum. Datum width taken at 3,121 feet.

Slope gauges were 8,400 feet apart on the left bank, the lower one being about 1,700 feet below the discharge section; for results see slope table.

Fulton, Tenn.—Section line is about normal to the direction of the current, and about 5,000 feet above the landing at Fulton, Tenn.

This discharge section is about 1,600 feet above that used in 1879–'80 and 1884.

Azimuth of section, R. B. to L. B., 330°.

R. B. Shore line from B. M. $\frac{4}{5}$, 1,150 feet; azimuth 260° 00′.

L. B. Shore line from B. M. $\frac{4}{5}$, 950 feet; azimuth 225° 10′.

The above are derived from a location of the section on a M. R. C. map, scale 1 inch = 1 mile, received from district officer, and transferred to chart, scale 1:20000. Divergence is very small, hence the point of intersection is not given.

The float paths were plotted to a scale of 1 inch = 100 feet, and from this velocities were derived.

The soundings and velocities were plotted on cross-section paper to a horizontal scale of 1 inch = 100 feet, and vertical scales of 1 inch = 20 feet for soundings, and 1 inch = 2 feet per second for velocities.

The distances of end velocity stations varied from about 30 to 75 feet on the deep side, and from 70 to 200 feet on the shallow side of the river. The end soundings were generally taken less than 50 feet from shore.

For computing area and discharge, soundings were scaled off from the plots every 50 feet, and the velocities every 100 feet, except that where the curves were very regular the distance between velocities was increased.

The observer attributes apparent discrepancies in results of first few days to the lead line (see field report), but considerable changes in velocity are also noticeable. The readings are given of standard M. R. C. gauge at Fulton, Tenn., whose zero is 228.55 feet above the Cairo datum plane.

Datum line is taken at 250.10 feet on the local gauge at section, which was the reading of April 30 and May 2, 1892; the datum width is taken at 2,570 feet. The tabulated slope is from reduction at district office.

Helena, Ark.—The discharge section is shown on a map, scale 1:20000, accompanying the field notes, to have the left bank end on line with the Memphis and Helena Railroad and the right bank end about 300 feet below the elevator; the section is nearly in prolongation of the Memphis and Helena Railroad, as it enters Glendale, Miss.

Right bank shore line, from B. M. $\frac{3}{5}$, 800 feet; azimuth 245°.

Left bank shore line, from $\frac{3}{5}$, 2,740 feet; azimuth 42°.

Section line intersects stone line 22 at 1,280 feet from B. M. $\frac{3}{5}$, divergence 25° 20′ downstream.

Azimuth of section line from R. B. to L. B., 288° 05′.

The soundings and velocities were at irregular distances apart; soundings were mainly about 50 feet apart, except near the shores where the distances were generally much less. Distances apart of velocities varied, being mainly about 200 feet in deep parts and about 300 feet in shallow parts, or where velocities changed but little.

The cross sections were plotted to a scale of 1 inch = 300 feet horizontal, and 1 inch = 20 feet vertical, and velocities plotted in meter registrations per second.

NOTE.—Geodetic positions are from scaling on the 1:20000 M. R. C. charts, and shore lines are as shown on same charts, unless otherwise stated.

*This gauge was connected with stone line B. M. § by duplicate line of levels of inspection party in November, 1892. If the elevation of B. M. § is correct, then the gauge is 0.25 feet too low. No correction has been applied to the reading tabulated here. Connection with P. B. M. 8 at Columbus, by river crossing, will be made as early as practicable; meanwhile the elevation is doubtful.

From these plots soundings were scaled off every 150 feet and velocities every 300 feet, except where velocities changed rapidly between stations, in which case they were scaled every 150 feet and soundings 75 feet. The end areas for about 500 feet from shore were computed precisely from the sounding notes.

Velocities were generally observed within 300 feet of shore, but the distance varied from about 170 to 370 feet.

The same meter and rating was used as at Columbus, and length of time at stations was also about the same. (See page 3676.)

Datum line was taken at 45.73 feet on the standard United States Engineer gauge, whose zero is 161.98 feet above the Cairo datum plane. Datum width taken at 5,119 feet, as observed May 11, 1892.

Slope gauges were 12,570 feet apart on the right bank, the upper one being about 2,500 feet above the discharge section.

Chicot City, Ark.—For description of location of discharge section and distances between velocity stations, etc., see field report on page 3671.

The soundings were located in the usual manner from a 3,000-foot base, the distance apart rarely exceeding 75 feet. Distances out of these were checked from the angles, also corrections to lead line were checked. The cross sections were plotted to a horizontal scale of 1 inch = 200 feet and vertical 1 inch = 20 feet, and soundings scaled from the plots every 75 feet between the velocity stations, and from these the partial areas were computed; the end areas were computed directly from the notes.

From the location of Station I it did not give a good mean velocity for the end area, for this area, therefore, the velocity at Station I was corrected by adding one-sixth of the difference between Stations J and II. At all the other stations the observed velocity was applied directly to its corresponding partial area.

The meter ratings used were as described for Arkansas City and given in table meter ratings. The results of low velocity ratings were used at Station XIV.

The meter was run at each station generally for five minutes.

Float observations were reduced in the usual manner.

The datum line was taken at water surface level at the discharge section on June 28, which is approximately 165.2 feet above the Cairo datum plane. The gauge readings tabulated are as observed by the discharge party on the Arkansas City gauge, whose zero elevation is 116.44 feet above the Cairo datum plane.

Datum width 4,054 feet.

The discharge over bank was observed June 29, and assumed to be constant from June 28 to July 2.

Arkansas City, Ark.—(See also field report, p. 3665.) The discharge section is in same position as in 1891; a field sketch, dated June 4, 1891, scale 1 inch = 300 feet, shows the section intersecting the Arkansas shore 2,646 feet downstream from center of elevator building at Arkansas City. The magnetic bearing of section line is stated to be N. 41° 10′ W.

On the same sketch a B. M. (probably stone line B. M. $\frac{63}{y}$ is shown 1,300 feet from intersection of left bank and section line; bearing E. (magnetic) and a P. B. M. (probably P. R. M. 84) is shown distant from same intersection 1,080 feet, bearing E. 14° S. (magnetic).

The discharge section of 1889 and 1890 intersects the Arkansas shore at same point and the Mississippi shore 100 feet above the present section.

The soundings were generally well distributed across the river, distance apart seldom reaching 100 feet, and near the shores being less than 50 feet.

The distances out of soundings and corrections to lead line in note books were checked.

The partial areas were computed directly from the soundings up to May 19, and after that the soundings were scaled from the plotted cross sections at intervals of 75 feet, and 50 feet near shore, and from these the areas were computed.

The scale of cross section plots was horizontal 1 inch = 200 feet to 1 inch = 20 feet vertical.

The velocity stations were 300 feet apart across the river (except Stations I and II, which were 240 feet apart); the end velocity stations were about 110 and 120 feet from shore. The observed velocities were applied to the corresponding partial areas in computing the discharge. The meter was generally run for five minutes at each station.

No correction for motion of boat, noted in the field report, has been applied. On days when piano wire soundings were taken on same day as the ordinary line soundings, areas by both methods, computed separately, are given; also separate discharges.

The old meter, No. 5, and two new ones, Nos. 38 and 39, were used in measuring velocities. These meters were rated several times during the season, and the results of final reduction in this office are given in table on page 3700. The different series were divided at about 3 feet per second velocity, and the upper and lower groups of each series reduced separately.

The results of the higher groups were used for reducing the river velocities, and that of the lower group for over-bank flow. The results of each group for the different meters have been combined in the usual manner by weighting the constants inversely as the squares of the respective mean errors of the constants. The resulting values are given in the table. Meter No. 39 was taken apart April 28, hence the rating of April 23 was not combined with later ratings, but used separately for discharges of April 22 to 27. The float observations were reduced in the usual manner.

The gauge readings tabulated are from the gauge at elevator and as reported by the observation party; the elevation of zero of this gauge is 116.44 feet above the Cairo datum plane.

Datum line is taken at 41.73 feet on the gauge and datum width at 3,416 feet, both the same as in 1891.

Over-bank discharge was measured April 25, May 3, 5, 11, 19, and 31, June 10 and 22, and July 1, and from these the bank discharges for intervening dates were interpolated.

Wilson Point, La.—For position of velocity stations, methods of observation, etc., see field reports, pp. 3669 and 3672.

The discharge section is shown on a sketch accompanying the field notes, scale 1:10000, with the right bank end about 250 feet above Wilson Point Landing; the azimuth of section R. B. to L. B., is 248° 32′, measured on same sketch. This section was used in both high and low-water discharges this year, and was also used in 1891.

The distances out of soundings were checked from the angles, and also lead line corrections to soundings checked. The cross sections were plotted to a scale of 1 inch = 200 feet horizontal and 1 inch = 10 feet vertical, and for these plats the soundings were scaled off every 75 feet; for the low water set soundings were scaled every 50 feet except near shore, since the velocity stations in the low-water observations, were 100 feet apart. End soundings were taken directly from the notes. From these scaled soundings the partial areas were computed, and the velocities observed at the different stations applied to the corresponding partial areas, except at Station I, during high water, where the observed velocity was increased by adding one-fourth of the difference between that and the velocity observed at Station II, to compensate for the nearness of Station I to shore; see field report.

The new Price meters Nos. 38 and 39 were used in measuring velocities, and also double floats.

The results of ratings of the meters, given in table on page 3700, and as described for Arkansas City, were used in computing high-water discharges; for the low-water discharges meter No. 38, with rating of November 26, was used.

Where meter and floats are used on the same day the same set of soundings is used in obtaining both discharges; hence the area quantities are not repeated in the table.

In the low-water discharges the meter was held at 10 feet below the surface, except near shore, and these observed velocities were reduced to correspond to six-tenths depth by the table given in Mississippi River Commission Report for 1884, p. 189, last line.

Two discharges are given for October 26, one using all the stations 100 feet apart, and the other using only the regular stations, 300 feet apart, the same soundings being used.

The Lake Providence gauge readings tabulated are from the regular gauge reports. The zero of this gauge is 89.62 feet above the Cairo datum plane. The "local gauge" readings are the elevations of the water surface at the discharge section above a horizontal plane at same elevation as that of the zero of the Lake Providence gauge. The datum line is taken at 41.83 feet on this local gauge as tabulated.

The width at datum line was taken as observed at 3,938 feet.

In computing the low-water datum areas the same datum line and width were taken; and at 39.43 feet and 37.43 feet the widths were taken, as observed during high water, at 3,923 and 3,841 feet, respectively. Between these heights the slope of bank was assumed to be uniform, and also between the last height and the water surface.

The overbank discharge given in the table was on the Mississippi side of the river, as described in field report. The dates it was observed are noted in the table; for the intervening dates it is interpolated in proportion to time.

Crevasse measurements, third district.—(For field reports see pp. 3666 and 3671.) In this re-computation only obvious errors in the first computation were corrected, the judgment of the observer being accepted where it was evidently his intention to allow for small irregularities or insufficient observations.

The results of meter ratings on p. 3700 were used in computing discharges, the low velocity groups being generally taken.

Where the submergence of meter is not noted on the table it was assumed to be six-tenths of the depth.

The widths of the breaks tabulated are mainly copied from field reports. Since the discharge range was not always in line between ends of break its width would some-

times be greater than that tabulated. The discharge of Brooks Mill crevasse was observed May 25 also, but the results are not tabulated since the district officer regards them as worthless.

The observer notes, June 1, for Leland crevasse that conditions were unfavorable, but thinks results as given can be relied on to within 10 per cent.

Natchez, Miss.—A rough sketch, accompanying notes of 1891, shows section to be immediately in front of the town of Vidalia and normal to the direction of the river. The left-bank end is about 3,300 feet below where Orleans street, Natchez, if produced, would intersect the shore line.

R. B. shore line from B. M. $\frac{1}{2}^{2}$, 1,900 feet; azimuth, 345° 20′.

R. B. shore line from /\ East Base = P. B. M. LXIII, 1,100 feet; azimuth, 20° 10′.

L. B. shore line from B. M. $\frac{1}{2}^{2}$, 850 feet; azimuth, 81°.

Section line nearly parallel with stone line 132; azimuth, 323° 30′.

It is stated in notebook that the discharge section is in same position as in 1891.

The distances between stations varied from 98 to 200 feet, except that until May 28 the distance from station 11 to station 12 was 224 feet, when station 12 was moved to make this 200 feet.

The distance of end stations from shore was about 100 feet until May 30, when the "distance out" of left-bank station was increased to 129 feet by the change above noted.

Until May 20 the boat was not exactly at the established stations on account, the observer states, of new crew. The departure from stations however is exactly noted.

Velocities were measured with the Price current meter No. 25. The time of an observation varied from about one minute to three minutes, but was generally less than one and one-half minutes. At stations 5 to 9, after the first few days, the meter was held at two-tenths depth and at other stations was held at from three-tenths to eight-tenths depth.

Since the meter was held at two-tenths depth for the greatest number of stations, all the others were first reduced to this depth, and the whole result finally reduced to six-tenths depth, using the values for the different depths given in Mr. Price's tables. This method of observing obviously increases the work of reduction and also introduces an additional series of assumptions between the observations and the final result, besides those involved in the adopted method of computation.

The notebook contains two sets of observations for rating the meter, July 2 and July 12, 1892, respectively; but as the first set was marked "no good," only the second set was reduced and used in computing discharges. For results of reduction see table of meter ratings.

Datum line was taken at 48.08 feet on the United States Engineer gauge, and datum width at 2,179 feet, both as observed June 25, 1892. Datum line was taken at this height because the river width at datum height of last year was not observed this season.

Mr. G. Ed. Mott, assistant engineer, who was the observer during the season, states in a letter that up to May 19 the observations are not reliable on account of new crew. In the notebook the observations of June 23 and 24 are also questioned for the same reason.

The formula correction to discharge was from about 2,100 to 3,700 cubic feet per second.

Red River Landing, La.—The discharge section is shown on sketch scale 1 inch = 1 mile to be due east and west, latitude 30° 57′ + 2,340 feet, and is at Red River Landing.

R. B. end is said to be nearly at same place as section of former years, but left-bank end is moved downstream to make section normal to direction of the current.

R. B. shore line from B. M. $\frac{1}{2}^{3}$, 5,000 feet; azimuth, 351°.

L. B. shore line from B. M. $\frac{1}{2}^{2}$, 4,100 feet; azimuth, 22° 30′.

Section line (produced inshore) intersects stone line No. 150 at 4,700 feet from B. M. $\frac{1}{2}^{2}$ divergence 45° upstream.

Range signals on left bank were used to locate stations. The stations were mainly 200 feet apart, except near shore, where they were 100 and 120 feet apart. End stations were 98 to 120 feet from right bank and 56 to 138 feet from left bank.

NOTE.—In the fourth district, comprising Natchez, Red River Landing, Simmsport, and Carrollton, the sounding and velocity stations were coincident and were maintained at the same places on the discharge section throughout the season, with some exceptions at Natchez, which are specially noted. The means of velocities at adjacent stations have been applied over the included areas to find the partial discharges. The usual formula correction for error due to this method has been approximately applied, the maximum correction at the Mississippi stations being about one-fourth of 1 per cent of the total discharge and about one-half of 1 per cent at Simmsport. Generally this correction is unimportant. Its range is given in the memoranda for each station.

Velocities were measured with the meter at mid depth until June 14, after which they were taken at four-tenths depth. These have all been reduced to six-tenths depth for computing discharge. The meter was run from two to three minutes at each station until May 11, and after that uniformly for two minutes at each station.

The notes contain tables of lead-line corrections up to May 13 for this station and Simmsport, and corrected soundings have been checked by these tables; but after that date Mr. Oliveira, the observer, states that "The corrections for each day's soundings were made by stretching the lead line alongside the tape line and reading off on the tape the correct soundings corresponding to each recorded reading on the lead line. The readings on the tape line were entered as the corrected soundings." The corrections, as given in the tables, seldom exceeded 1 foot and were generally one or two tenths of a foot.

Datum line was taken at 48.85 feet on the United States Engineer gauge and datum width at 4,046 feet, both as observed June 27, 1892. The formula correction for a total discharge was from about — 300 to + 700 cubic feet per second.

Mr. W. G. Price, assistant engineer, was observer until May 13, after that Mr. B. J. Oliveira. Slope gauges were read at the discharge section and at Rows Landing. The results are given in the accompanying slope tables.

The location map accompanying the discharge notes shows a flow over the left bank following the foot of the bluffs from Clarkes Lake, just below Fort Adams, and coming into the river again at Rows Landing, making a nearly straight cut across of about 8 miles long, which opposite the discharge section was about 4 miles from the river. No measurement or estimate is given of this overflow in the notes of discharge work.

*Simmsport, La.**—Two different discharge sections were used at this place, the first one stated to have been established by Mr. G. Ed. Mott, assistant engineer, between sill dams Nos. 1 and 3. This section was used until May 7. The stations were 100 feet apart, except near shore they were 50 and 60 feet apart. The end stations were about 30 and 70 feet out until April 7, and then about 70 feet from shore on both sides while this section was used. (See Red River Landing memorandum for notes on lead line.)

The second discharge section at this place, established by Mr. W. G. Price May 13, 1892, is shown on sketch to be located below the mouth of Bayou des Glaise and just above the mouth of Alligator Bayou. The stations were 100 feet apart, except near shore they were 60 and 70 feet apart. The end station at the right bank was about 60 feet from shore. The end station at the left bank was about 60 feet out from main shore.

As the river rose this bank was overflowed and an angle in levee just above formed a pocket, so that this overflowed part was dead water.

The datum line for first section used was taken at 42.33 feet on the gauge, and datum width at 1,056 feet, both as observed May 7.

The datum line for the second section was taken at 46.64 feet on the gauge, and datum width at 1,222 feet. In computing datum areas the width at 44.40 feet on the gauge was taken at 1,057 feet.

The Simmsport gauge readings are tabulated as reported by the discharge party. The zero is 24.17 feet above the Cairo datum plane.

The change of gauge in twenty-four hours is from the regular gauge reports, but since these reports were discontinued, May 15, and those of the discharge party are not continuous, this column is blank after May 13.

*Carrollton, La.**—The section is reported by observer to be at the same place as in 1891, who also states that the water width is greater than last year, owing to an old spur levee and batture being cut away in building a new levee.

A sketch, scale approx. 1:20000, shows the section to intersect the left-shore line about 600 feet above the foot of Carrollton avenue, Carrollton, La.

The section is normal to the direction of river at that place, and is about 1¼ miles above upper limit, at the river, of Audubon Park.

The stations were at irregular distances across the river, varying from 50 to 200 feet. The end station, at the deep side, 120 feet from shore, that at the shallow side was 250 feet from shore.

Velocities were measured with Price meter No. 22. The meter was held at four-tenths depths at stations covering the deepest part of the river, and at others at five-tenths and six-tenths. They were all reduced to six-tenths depth before computing discharge. The meter was run for two minutes at each station, except that on June 30 about half the stations were observed for one minute, and one station for three minutes.

The meter was rated June 8, and the results used in computing discharges. See table of meter ratings for values.

The observer reports lead line correct. Datum line is taken at 17 feet on the United States Engineer gauge and datum width at 2,490 feet, as observed June 10, 1892.

---

*See note on page 3679.

The formula correction was about 200 to 800 cubic feet per second for a total discharge.

Mr. William Garvin, assistant engineer, was the observer during the season.

Arkansas River, Little Rock, Ark.*—(See also field report on p. 3673.) The mean cross section, derived as described in field report, was plotted to a horizontal scale of 1 inch=100 feet; vertical, 1 inch=10 feet, and from these plots soundings were scaled every 100 or 150 feet for computing areas.

The floats were run over a distance between ranges of 3,200 feet. The upper range was 1,600 feet below the railroad bridge over the Arkansas River. This bridge is stated to be about 5,000 feet below the "Baring Cross" Bridge, upon which the United States Engineer gauge is located.

The end velocity stations were less than 150 feet from shore and the maximum distance between observed velocities on May 23 was about 300 feet and on May 24 about 500 feet. These observed velocities were plotted on the cross sections to a vertical scale of 1 inch=2 feet per second, and from these plats velocities were scaled off mainly 200 feet apart, and the discharges computed in the usual manner.

The Little Rock gauge in the tabulation is the standard United States Engineer gauge, whose zero is 241.55 feet above the Cairo datum plane.

Ouachita River, Monroe, La.—(See field report on p. 3673.) The discharge section is shown on a map, scale 1 inch=400 feet, accompanying the notes, to be normal to the direction of the river. The left-bank end is 2,320 feet below the south line of Calypso street, Monroe. The section is three-fourths of a mile below the Vicksburg, Shreveport, and Pacific Railroad Bridge over the Ouachita River.

Velocities were observed on May 31 and June 1. Soundings were taken only on May 30, and these soundings were corrected for change of stage and used for obtaining areas for May 31 and June 1. The observations were carefully distributed across the river; the velocities were taken on May 30 about 50 and 100 feet from the shores, but on June 1 the velocity at 100 feet out was borrowed from the day before, as it was not observed June 1 at this point.

The cross sections were plotted from soundings corrected, as above noted, to a scale of 1 inch=100 feet horizontal and 1 inch=10 feet vertical; velocities were plotted on these to a scale of 1 inch=1 foot per second.

Soundings were scaled from these plots every 25 feet, and velocities every 50 feet, and from these the areas and discharges were computed in the usual manner.

The Monroe gauge, whose readings are tabulated, is that reported by the United States Weather Bureau. The preliminary value of its zero is 51.55 above the Cairo datum plane.

Red River, Alexandria, La.—(See field report on p. 3674.) The discharge section is described as being immediately in front of the town of Alexandria, and is shown by a sketch in the notebook to be exactly in prolongation of the southeast line of Lee street, and normal to the direction of the river. The soundings were at irregular distances across the river, located by transit angles from an 800-foot base; the distances apart of the soundings varied, generally being from about 20 to 60 feet; in a few cases being from 5 or 6 to over 100 feet apart.

No lead-line corrections are given. The areas between soundings were computed precisely from the notes, and these were grouped into partial areas to correspond to each velocity station.

The floats crossed the discharge section at irregular distances apart across the river. The observed velocity, derived from the float, was applied to the corresponding partial area. The end-velocity stations were generally less than 50 feet from shore, and soundings were frequently less than 10 feet from shore. The velocities observed at the end stations were applied from the shore to halfway out to the second velocity station.

From the measured discharges over bank of June 10 and 14 this discharge for included dates was interpolated, and also for June 15, assuming that the change was proportional to the time and having regard to change of stage.

The datum line was taken at 38.24 feet on the United States Engineers gauge whose zero is 64.46 feet above the Cairo datum, and datum width is taken at 820 feet, both as observed June 13, 1892.

For results of slope observations see tables.

---

* For measurement of flood escape of Arkansas River through levees below Pine Bluff, see report of Mr. Tollinger, on p. 3667.

Results of discharge observations, Mississippi River.

ST. LOUIS, MO.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	St. Louis.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
May 20*	35.70	.....	—0.2	103,956	.....	54.7	.....	78.6	1,901	.....	9.623	1,000,331	43,000	1,043,331	2	41	
21†	35.20	.....	—0.5	94,361	.....	53.6	.....	85.6	1,762	.....	12.149	1,146,415	0	.....	8	11	

*Discharge section at Merchants Bridge.

† Discharge section at Pittsburg dike, about 4½ miles below Merchants Bridge.

COLUMBUS, KY.

[Section same as 1891. Datum line 40'.55 on Belmont gauge. Velocities obtained with meter.]

Apr. 13*	†41.28	.....	—0.0	202,574	200,295	64.9	64.2	86.0	3,122	+12,602	6.415	1,299,518	.....	.....	18	40	VIII—Strong.
15	41.20	.....	—0.1	190,295	188,266	60.9	60.3	79.8	3,123	−12,029	6.319	1,202,518	.....	.....	18	33	Calm.
16	41.00	.....	—0.1	189,291	187,887	60.7	60.2	79.8	3,121	− 379	6.142	1,162,625	.....	.....	17	36	IV—Slight.
26	42.96	.....	+0.2	203,614	196,035	64.3	62.8	86.0	3,169	+ 8,148	6.701	1,364,430	.....	.....	19	59	Calm.
27	43.00	.....	+0.1	205,752	198,047	64.9	63.5	84.5	3,169	+ 2,012	6.724	1,383,577	.....	.....	18	52	V—Medium.
28	43.10	.....	+0.1	206,257	198,237	65.1	63.5	84.0	3,169	+ 190	6.776	1,397,568	.....	.....	18	44	V—Medium.
29	43.10	.....	—0.1	205,071	197,051	64.7	63.1	85.0	3,169	− 1,186	6.594	1,352,221	.....	.....	17	47	X—Slight.
30	42.88	.....	—0.2	205,729	198,401	64.9	63.6	85.0	3,169	+ 1,350	6.810	1,401,052	.....	.....	19	52	I—Slight.

† Belmont gauge.

*Raining.

times be greater than that tabulated. The discharge of Brooks Mill crevasse was observed May 25 also, but the results are not tabulated since the district officer regards them as worthless.

The observer notes, June 1, for Leland crevasse that conditions were unfavorable, but thinks results as given can be relied on to within 10 per cent.

Natchez, Miss.—A rough sketch, accompanying notes of 1891, shows section to be immediately in front of the town of Vidalia and normal to the direction of the river. The left-bank end is about 3,300 feet below where Orleans street, Natchez, if produced, would intersect the shore line.

R. B. shore line from B. M. $1\frac{1}{2}$, 1,900 feet; azimuth, 345° 20′.

R. B. shore line from ∧East Base = P. B. M. LXIII, 1,100 feet; azimuth, 20° 10′.

L. B. shore line from B. M. $1\frac{1}{2}$, 850 feet; azimuth, 81°.

Section line nearly parallel with stone line 132; azimuth, 323° 30′.

It is stated in notebook that the discharge section is in same position as in 1891.

The distances between stations varied from 98 to 200 feet, except that until May 28 the distance from station 11 to station 12 was 224 feet, when station 12 was moved to make this 200 feet.

The distance of end stations from shore was about 100 feet until May 30, when the "distance out" of left-bank station was increased to 129 feet by the change above noted.

Until May 20 the boat was not exactly at the established stations on account, the observer states, of new crew. The departure from stations however is exactly noted.

Velocities were measured with the Price current meter No. 25. The time of an observation varied from about one minute to three minutes, but was generally less than one and one-half minutes. At stations 5 to 9, after the first few days, the meter was held at two-tenths depth and at other stations was held at from three-tenths to eight-tenths depth.

Since the meter was held at two-tenths depth for the greatest number of stations, all the others were first reduced to this depth, and the whole result finally reduced to six-tenths depth, using the values for the different depths given in Mr. Price's tables. This method of observing obviously increases the work of reduction and also introduces an additional series of assumptions between the observations and the final result, besides those involved in the adopted method of computation.

The notebook contains two sets of observations for rating the meter, July 2 and July 12, 1892, respectively; but as the first set was marked "no good," only the second set was reduced and used in computing discharges. For results of reduction see table of meter ratings.

Datum line was taken at 48.08 feet on the United States Engineer gauge, and datum width at 2,179 feet, both as observed June 25, 1892. Datum line was taken at this height because the river width at datum height of last year was not observed this season.

Mr. G. Ed. Mott, assistant engineer, who was the observer during the season, states in a letter that up to May 19 the observations are not reliable on account of new crew. In the notebook the observations of June 23 and 24 are also questioned for the same reason.

The formula correction to discharge was from about 2,100 to 3,700 cubic feet per second.

Red River Landing, La.—The discharge section is shown on sketch scale 1 inch = 1 mile to be due east and west, latitude 30° 57′ + 2,340 feet, and is at Red River Landing.

R. B. end is said to be nearly at same place as section of former years, but left-bank end is moved downstream to make section normal to direction of the current.

R. B. shore line from B. M. $1\frac{1}{2}$, 5,000 feet; azimuth, 351°.

L. B. shore line from B. M. $1\frac{1}{2}$, 4,100 feet; azimuth, 22° 30′.

Section line (produced inshore) intersects stone line No. 150 at 4,700 feet from B. M. $1\frac{1}{2}$ divergence 45° upstream.

Range signals on left bank were used to locate stations. The stations were mainly 200 feet apart, except near shore, where they were 100 and 120 feet apart. End stations were 98 to 120 feet from right bank and 56 to 138 feet from left bank.

NOTE.—In the fourth district, comprising Natchez, Red River Landing, Simmsport, and Carrollton, the sounding and velocity stations were coincident and were maintained at the same places on the discharge section throughout the season, with some exceptions at Natchez, which are specially noted. The means of velocities at adjacent stations have been applied over the included areas to find the partial discharges. The usual formula correction for error due to this method has been approximately applied, the maximum correction at the Mississippi stations being about one-fourth of 1 per cent of the total discharge and about one-half of 1 per cent at Simmsport. Generally this correction is unimportant. Its range is given in the memoranda for each station.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.

[Section is approximately same as 1888-'89; datum line taken at 45'.73 on standard gauge, as observed May 11, 1892. Velocity taken with meter.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Helena.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
Apr. 18	42.60	.....	+0.2	206,318	222,309	40.5	43.4	97.0	5,099	.....	5.207	1,074,297	.....	.....	24	53	VI—Strong.
19	42.73	.....	+0.1	215,463	230,799	42.3	45.1	97.0	5,099	+8,481	4,829	1,040,448	.....	.....	22	48	IV—Light.
20	42.87	.....	+0.2	217,881	232,494	42.7	45.4	96.0	5,100	+1,704	5.037	1,097,506	.....	.....	21	51	II—Mild (rain).
21	43.25	.....	+0.4	215,933	228,583	42.3	44.7	96.0	5,101	−3,911	5.159	1,113,991	.....	.....	23	55	XI—Light.
May 3	44.50	.....	+0.1	219,345	225,641	42.9	44.1	98.4	5,118	−2,942	5.512	1,209,040	.....	.....	20	58	V—Strong.
4	44.64	.....	+0.1	221,685	227,264	43.3	44.4	97.0	5,118	+1,623	5.440	1,205,860	.....	.....	22	66	VI—Medium.
5	44.77	.....	+0.1	223,389	228,303	43.6	44.6	96.0	5,118	+1,039	5.643	1,260,657	.....	.....	22	68	VI—Mild.
6	44.88	.....	+0.1	225,445	229,796	44.0	44.9	96.0	5,118	+1,493	5.570	1,255,669	.....	.....	22	60	Calm.
7	44.98	.....	+0.1	226,478	230,317	44.3	45.0	96.5	5,118	+ 521	5.446	1,233,422	.....	.....	21	56	I—Light.
9	45.48	.....	+0.3	227,844	229,124	44.5	44.8	96.0	5,119	−1,193	5.467	1,245,649	.....	.....	23	63	Calm.
10	45.66	.....	+0.2	229,200	229,558	44.8	44.8	97.0	5,119	+ 434	5.630	1,290,339	.....	.....	22	70	X—Light.
11	45.73	.....	+0.1	230,793	230,793	45.1	45.1	97.0	5,119	+1,235	5.747	1,326,393	.....	.....	21	74	XI—Light.
12	45.69	.....	−0.1	229,515	229,720	44.8	44.9	97.0	5,119	−1,073	5.720	1,312,758	.....	.....	22	66	I—Light.
13	45.51	.....	−0.2	229,750	230,876	44.9	45.1	97.0	5,119	+1,156	5.749	1,320,835	.....	.....	20	62	V—Light.
14	45.26	.....	−0.3	228,263	230,669	44.6	45.1	96.0	5,118	− 207	5.762	1,315,245	.....	.....	22	74	VI—Strong.
16	44.77	.....	−0.2	225,814	230,727	44.1	45.1	96.0	5,117	− 58	5.631	1,271,449	.....	.....	21	73	Calm.
17	44.55	.....	−0.2	222,701	228,740	43.5	44.7	96.0	5,117	−1,987	5.613	1,250,076	.....	.....	22	64	V—Mild.
June 1	44.67	.....	+0.2	220,857	226,282	43.2	44.2	95.0	5,117	−2,458	5.647	1,247,267	.....	.....	23	69	VI—Strong.
2	44.70	.....	0.0	221,186	226,458	43.2	44.2	96.0	5,117	+ 176	5.400	1,194,372	.....	.....	23	64	IX—Mild.
3	44.66	.....	−0.1	218,314	223,790	42.7	43.7	95.0	5,117	−2,668	5.393	1,177,335	.....	.....	22	77	XII—Mild.
4	44.61	.....	0.0	219,631	225,363	42.9	44.0	94.0	5,117	+1,573	5.372	1,179,837	.....	.....	22	69	Calm.
6	44.56	.....	0.0	218,173	224,161	42.6	43.8	95.0	5,117	−1,202	5.432	1,185,121	.....	.....	22	69	Calm.
7	44.60	.....	+0.1	219,109	224,892	42.8	43.9	96.0	5,117	+ 731	5.371	1,176,781	.....	.....	23	66	XI—Light.
8	44.62	.....	0.0	221,033	226,713	43.2	44.3	96.0	5,116	+1,821	5.418	1,197,662	.....	.....	22	65	V—Light.
9	44.72	.....	+0.1	223,042	228,212	43.6	44.6	96.5	5,118	+1,499	5.395	1,203,365	.....	.....	23	65	IV—Light.
10	44.77	.....	+0.1	224,478	229,392	43.9	44.8	96.0	5,118	+1,180	5.346	1,199,953	.....	.....	21	76	Calm.
11	44.86	.....	+0.1	225,550	230,004	44.1	44.9	96.0	5,119	+ 612	5.416	1,221,632	.....	.....	21	74	Calm.
13	45.00	.....	+0.1	225,329	229,066	44.0	44.7	96.0	5,119	− 938	5.355	1,206,720	.....	.....	21	64	Calm.
14	45.06	.....	0.0	226,445	229,875	44.2	44.9	96.0	5,119	+ 809	5.419	1,227,060	.....	.....	20	72	Calm.
15	45.11	.....	0.0	227,135	230,309	44.4	45.0	96.0	5,119	+ 434	5.420	1,230,973	.....	.....	21	73	Calm.
16	45.12	.....	0.0	228,214	231,337	44.6	45.2	95.0	5,119	+1,028	5.466	1,247,312	.....	.....	22	74	Calm.
17	45.06	.....	−0.1	227,090	230,520	44.4	45.0	96.0	5,119	− 817	5.328	1,209,975	.....	.....	21	74	VI—Medium.
18	45.00	.....	0.0	225,972	229,709	44.1	44.9	96.0	5,119	− 811	5.555	1,255,271	.....	.....	21	83	VI—Strong.
20	44.82	.....	−0.1	226,710	231,368	44.3	45.2	95.0	5,119	+1,659	5.456	1,236,852	.....	.....	21	75	VI—Light.
21	44.63	.....	−0.2	224,788	230,419	43.9	45.0	96.0	5,119	− 949	5.298	1,190,993	.....	.....	21	79	VI—Light.
22	44.45	.....	−0.2	225,240	231,792	44.0	45.3	96.0	5,119	+1,373	5.154	1,160,941	.....	.....	21	79	VI—Medium.

CHICOT CITY, ARK.

(Datum line taken at water surface at section June 28, which is approximately 165.2 feet above the Cairo datum plane.)

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Arkansas City.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.								
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
June 28	46.9	.....	—0.4	222,612	222,612	54.9	54.9	68.5	4,054	.....	5.805	*1,292,347	5,828	1,298,175	14	58	
29	46.6	.....	—0.6	224,686	225,902	55.4	55.7	70.0	4,054	+3,290	5.592	*1,256,538	5,828	1,262,366	14	57	
29	46.51	.....	—0.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡5,828	.....	7	21	
30†	46.07	.....	—0.5	217,609	221,034	53.7	54.5	68.0	4,054	—4,868	4.778	‡1,039,943	5,828	1,045,771	14	61	IX.
30§	45.97	.....	—0.5	.....	.....	.....	.....	.....	.....	.....	4.866	‡1,059,170	5,828	1,064,998	13	.....	
July 1	45.38	.....	—0.7	219,404	225,626	54.1	55.7	68.0	4,054	+4,592	4.646	‡1,019,530	5,828	1,025,358	14	57	XII—Light.
1	45.33	.....	—0.7	.....	.....	.....	.....	.....	.....	.....	4.879	‖1,070,856	5,828	1,076,684	14	.....	
2	44.56	.....	—0.6	209,995	219,481	51.8	54.1	66.5	4,054	—6,145	5.259	*1,104,287	5,828	1,110,115	14	61	Some wind.
2	44.56	.....	—0.6	.....	.....	.....	.....	.....	.....	.....	4.891	‡1,027,161	5,828	1,032,989	14	.....	

* Meter No. 38. † A. m. ‡ Meter No. 39. § P. m. ‖ Double floats.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.

[Datum line taken at 41.73′ on Arkansas City gauge. Velocities taken with meter except for discharges marked thus *, when double floats were used.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Arkansas City.	Local	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.								
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
Apr. 22*	46.00	.....	+0.4	225,270	209,918	65.2	61.5	88.0	3,453	.....	5.807	1,308,146	2,376	1,310,522	12	48	
23	46.35	.....	+0.2	241,132	224,579	69.8	65.7	91.0	3,453	+14,661	6.002	1,447,253	3,675	1,449,928	12	48	
25	46.90	.....	+0.1	239,831	221,389	69.5	64.8	93.0	3,453	— 3,190	5,761	1,381,748	3,274	1,385,022	12	48	
26	47.07	.....	+0.2	247,044	228,010	71.5	66.7	93.0	3,455	+ 6,621	6,161	1,521,971	3,663	1,525,634	12	50	
27	47.25	.....	+0.1	246,354	226,702	71.3	66.4	95.0	3,455	— 1,308	6.468	1,593,377	4,052	1,597,429	12	47	Windy.
28	47.45	.....	+0.3	248,870	228,514	71.9	66.9	95.0	3,461	+ 1,812	6.109	1,520,396	4,441	1,524,837	12	56	
29	47.61	.....	+0.2	251,600	230,694	72.7	67.5	95.0	3,461	+ 2,180	6.128	1,541,833	4,830	1,546,663	12	54	Downstream. Strong.
30	47.78	.....	0.0	252,906	231,415	73.1	67.7	95.0	3,461	+ 721	6.256	1,582,280	5,219	1,587,499	12	55	
*May 2	47.96	.....	+0.1	246,564	224,454	71.2	65.7	95.0	3,461	— 6,961	6.564	1,618,559	5,997	1,624,556	12	51	Upstream.
3	48.02	.....	+0.1	247,551	225,235	71.5	65.9	94.0	3,461	+ 781	6.166	1,526,488	6,387	1,532,875	12	49	
4‖	48.10	.....	0.0	246,407	223,816	71.2	65.5	95.0	3,461	— 1,419	7.009	1,727,117	6,559	1,733,676	12	52	
4‖	48.10	.....	0.0	.....	.....	.....	.....	.....	.....	.....	7.041	1,734,967	6,559	1,741,526	12	.....	
5	48.25	.....	+0.1	248,712	225,605	71.9	66.0	93.0	3,461	+ 1,789	6.363	1,582,441	6,731	1,589,172	12	52	Light.
6	48.33	.....	+0.2	247,726	224,344	71.6	65.7	95.0	3,461	— 1,261	6.625	1,641,256	6,871	1,648,137	12	52	Calm.
7	48.55	.....	+0.1	247,198	223,059	71.4	65.3	95.0	3,461	— 1,285	6.500	1,606,703	7,011	1,613,714	12	52	
9	48.75	.....	0.0	249,627	224,801	72.1	65.8	95.0	3,461	+ 1,742	6.621	1,652,706	7,291	1,659,997	12	50	High.
10	48.80	.....	0.0	247,249	222,251	71.4	65.1	94.9	3,461	— 2,550	6.447	1,594,666	7,431	1,601,497	12	51	High to light.
11	48.88	.....	+0.2	248,656	223,383	71.8	65.4	95.5	3,461	+ 1,132	5.975	1,485,630	7,571	1,493,201	12	51	Light.
12	48.95	.....	0.0	249,755	224,241	72.2	65.6	94.5	3,461	+ 858	6.200	1,548,413	7,652	1,556,065	12	50	
13	49.14	.....	+0.2	248,170	222,093	71.7	65.6	95.5	3,461	— 2,298	5.879	1,458,873	7,733	1,466,606	12	51	
14	49.14	.....	0.0	243,345	217,178	70.3	63.6	95.0	3,461	— 4,825	5.761	1,401,997	7,814	1,409,811	12	51	Slight.
16	49.10	.....	0.0	250,912	224,882	72.5	65.8	96.0	3,461	+ 7,704	5.756	*1,444,252	7,976	1,452,228	12	50	
19	49.15	.....	0.0	251,441	225,239	72.6	65.9	95.5	3,461	+ 357	5.793	1,456,502	8,221	1,464,723	12	51	
21	49.27	.....	+0.1	247,559	220,945	71.5	64.7	90.	3,461	—4,294	5.647	1,397,985	8,317	1,406,302		(50	Slight.
23	49.40	.....	+0.1	250,968	223,907	72.5	65.5	96.	3,461	+2,962	5.685	1,426,841	8,413	1,435,254		51	
23	49.40	.....	+0.1	.....	.....	.....	.....	.....	.....	.....	5.843	*1,466,317	8,413	1,474,730		...	
24	49.46	.....	0.0	247,954	220,687	71.6	64.6	95.5	3,461	—3,220	5.708	1,415,237	8,461	1,423,698		51	
26	49.59	.....	+0.1	251,889	224,175	72.8	65.6	97	3,461	+3,488	5.701	1,436,119	8,557	1,444,676		51	Light.
27	49.64	.....	+0.1	250,857	222,971	72.5	65.3	96	3,461	—1,204	5.661	1,420,014	8,605	1,428,619		51	Calm.
28	49.73	.....	0.0	250,868	222,672	72.5	65.2	96	3,461	— 299	5.730	1,437,497	8,653	1,446,150		50	High.
30	49.82	.....	0.0	249,698	221,193	72.1	64.7	96	3,461	—1,479	5.735	1,432,000	8,749	1,440,749		49	Calm to brisk.
31	49.82	.....	0.0	248,349	219,844	71.8	64.4	94.5	3,461	—1,349	5.945	1,476,534	8,796	1,485,330		52	Very strong.
June 1	49.88	.....	+0.1	251,289	222,577	72.6	65.2	95.5	3,461	+2,733	5.876	1,476,603	8,743	1,485,346		51	Calm.
3	49.73	.....	—0.1	246,607	218,411	71.3	63.9	94	3,461	—4,166	5.952	1,467,892	8,639	1,476,531		52	West.—Light.
4	49.60	.....	—0.1	245,821	218,072	71.0	63.8	92	3,461	— 339	5.873	1,443,738	8,587	1,452,325		57	

6	49.47	.....	0.0	243,470	216,168	40.3	63.3	91	3,461	−1,904	5.781	1,407,409	8,433	1,415,892		56	South.—Light.
7	49.43	.....	−0.1	251,458	224,294	72.7	65.7	96	3,461	+8,126	5.786	1,454,910	8,431	1,463,341		62	
8	49.39	.....	0.0	251,761	224,734	72.7	65.8	95	3,461	+ 440	5.784	1,456,230	8,379	1,464,609		68	Light.
9	49.39	.....	0.0	254,831	227,804	73.6	66.7	96	3,461	+3,070	5.790	1,475,400	8,327	1,483,727		61	
10	49.42	.....	0.0	253,040	225,910	73.1	66.1	94	3,461	−1,894	5.822	1,473,122	8,275	1,481,397		63	South.—Light.
11	49.44	.....	0.0	253,347	226,148	73.2	66.2	95.5	3,461	+ 238	5.738	1,453,676	8,178	1,461,854		60	Light.
13	49.45	.....	0.0	248,400	221,167	71.8	64.7	94	3,461	−4,981	5.811	1,443,467	7,990	1,451,457		66	SE.—Light.
14	49.45	.....	0.0	15,300	218,067	70.9	63.8	93	3,461	−3,100	5.862	1,437,988	7,897	1,445,885	12	74	E.—Light.
14	49.45	.....	0.0	242,025	214,792	69.9	62.9	93	3,461	−3,275	5.848	1,415,298	7,897	1,423,195		46	Do.
15	49.44	.....	0.0	247,206	220,007	71.4	64.4	93.6	3,461	+5,215	5.663	1,399,935	7,804	1,407,739		70	
16	49.37	.....	0.0	250,563	223,605	72.4	65.5	93.5	3,461	+3,698	5.782	1,448,859	7,711	1,456,570		52	
17	49.30	.....	−0.1	249,433	222,716	72.1	65.2	95	3,461	− 889	5.727	1,428,398	7,618	1,436,016		53	
18	49.20	.....	−0.1	248,128	221,755	71.7	64.9	94	3,461	− 961	5.702	1,414,865	7,525	1,422,390		50	SW.—Fair.
20	48.97	.....	−0.2	249,278	223,695	72.0	65.5	93	3,461	+1,940	5.604	1,597,002	7,339	1,404,341		52	
20	48.97	.....	−0.2	.....	.....	.....	.....	.....	.....	.....	5.591	*1,393,709	7,339	1,401,048		...	
21	48.85	.....	0.0	247,190	222,020	71.4	65.0	92.5	3,461	−1,675	5.616	1,388,210	7,246	1,395,456		51	
21	48.85	.....	0.0	§240,414	215,244	69.5	63.0	90	3,461	−6,776	5.608	1,348,311	7,246	1,355,557		45	
22	48.62	.....	−0.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,153	.....		...	
23	48.47	.....	−0.2	245,642	221,779	71.0	64.9	94	3,461	+6,535	5.446	1,337,836	6,604	1,344,440		52	
24	48.28	.....	−0.2	246,258	223,048	71.2	65.3	92.5	3,461	+1,269	5.498	1,353,958	6,055	1,360,013		54	Up stream.—Strong.
27	47.52	.....	−0.2	240,268	219,671	69.4	64.3	90	3,461	−3,377	4.979	1,196,262	4,408	1,200,670		56	X.—Brisk.
28	47.17	.....	−0.4	244,949	225,556	70.8	66.0	92	3,461	+5,885	4.798	1,175,157	3,859	1,179,016		59	II.—Light.
29	46.65	.....	−0.6	244,007	226,401	70.5	66.3	92	3,461	+ 845	4.824	1,177,005	3,310	1,180,315		52	SW.—Slight.
30	46.13	.....	−0.5	236,632	220,833	68.5	64.6	89	3,453	−5,568	5.024	1,188,932	2,761	1,191,693		52	SW.—Upstream, strong.
30	46.13	.....	−0.5	.....	.....	.....	.....	.....	.....	.....	4.994	*1,181,689	2,761	1,184,450		..	
July 1	45.49	.....	−0.7	239,929	226,328	69.5	66.3	89	3,453	+5,495	4.819	1,156,144	2,212	1,158,356		53	
1	45.49	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.752	*1,140,130	2,212	1,142,342		...	

*Observations doubtful. †A. m. ‡P. m. §Piano wire soundings.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.

[Datum taken at 41'.83 on local gauge as here tabulated. Velocities taken with current meter except where floats are noted.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Lake Providence.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
Apr. 16	36.2	39.43	+0.6	193,596	203,029	49.3	51.6	67.0	3,923	.....	5.637	1,091,388	.....	.....		67	VII.—Brisk.
18	37.2	40.38	+0.4	199,852	205,557	50.8	52.2	68.0	3,931	+ 2,528	5.583	1,115,787	.....	.....		68	VII.—Light.
19	37.5	40.61	+0.4	199,101	203,902	50.6	51.8	67.5	3,932	— 1,655	5.827	1,160,233	.....	.....		63	VII.—Brisk.
20	37.8	41.03	+0.3	203,787	206,936	51.8	52.5	68.5	3,934	+ 3,034	5.923	1,206,990	.....	.....		57	VII.—Fair.
21	38.2	41.28	+0.4	205,150	207,315	52.1	52.6	68.0	3,936	+ 379	5.846	1,199,389	.....	.....		63	I.—Light.
22	38.6	41.58	+0.4	205,281	206,265	52.1	52.4	68.5	3,937	— 1,050	5.830	1,196,788	*2,500	1,199,288		70	XII.—Light.
23	38.8	41.91	+0.2	211,642	211,327	53.7	53.7	70.0	3,939	+ 5,062	6.116	1,294,334	2,800	1,297,134		68	X.—Light.
25	39.5	42.52	+0.3	216,485	213,766	54.9	54.3	70.5	3,942	+ 2,439	6.088	1,317,979	*3,400	1,321,379		69	IV.—Light.
26	39.7	42.81	+0.2	217,613	213,751	55.2	54.3	70.0	3,944	— 15	6.156	1,339,655	4,400	1,344,055		62	V.—Light.
27	39.9	42.98	+0.2	212,689	208,157	53.9	52.9	70.5	3,944	— 5,594	6.325	1,345,290	5,300	1,350,590		76	VII.
28	40.2	43.19	+0.3	215,859	210,499	54.7	53.5	71.0	3,944	+ 2,342	6.420	1,385,873	6,300	1,392,173		65	VI.—Light.
29	40.4	43.50	+0.2	222,836	216,255	56.5	54.9	71.5	3,944	+ 5,756	6.278	1,399,014	7,200	1,406,214		79	XI.
30	40.6	43.67	+0.2	221,532	214,279	56.1	54.4	71.0	3,946	— 1,976	6.031	1,335,996	8,200	1,344,196		79	IX.
May 2	40.8	43.95	0.0	222,554	214,195	56.4	54.4	71.0	3,948	— 84	6.145	1,367,623	*11,100	1,378,723		84	VIII.—Fair.
3	40.9	44.05	+0.1	222,247	213,494	56.3	54.2	71.0	3,948	— 701	6.278	1,395,346	11,200	1,406,546		77	VII.—Brisk.
4	41.0	44.15	+0.1	224,834	215,086	56.9	54.9	71.5	3,948	+ 2,192	5.639	1,267,771	11,300	1,279,071		84	Do.
5	41.2	44.29	+0.1	222,008	212,308	56.2	53.9	69.5	3,948	— 3,378	6.130	1,360,946	11,500	1,372,446		75	VII.—Fresh.
6	41.3	44.45	+0.2	220,952	210,621	56.0	53.5	71.5	3,948	— 1,678	6.000	1,325,607	11,600	1,337,207		78	VI.—Light.
7	41.4	44.56	+0.1	224,300	213,536	56.8	54.2	71.0	3,948	+ 2,915	*6.111	1,370,802	11,700	1,382,502	13	83	VII.—Light.
9	41.6	44.83	+0.1	225,353	213,524	57.1	54.2	71.0	3,948	— 12	6.060	1,365,600	12,000	1,377,600		76	VIII.—Brisk.
10	41.6	44.67	—0.1	224,675	213,477	56.9	54.2	71.0	3,948	— 47	6.290	1,413,318	*12,100	1,425,418		71	XII.—Light.
11	41.4	44.58	—0.2	224,707	213,864	56.9	54.3	71.0	3,948	+ 387	5.852	1,315,071	12,800	1,327,871		97	I.—Light.
12	41.5	44.65	+0.1	225,417	214,298	57.1	54.4	71.0	3,948	+ 434	5.998	1,352,132	13,500	1,365,632		102	V.—Light.
14	41.6	44.83	+0.1	226,570	214,741	57.4	54.6	71.5	3,948	+ 443	5.680	1,286,834	15,000	1,301,834		105	VII.—Brisk.
16	41.5	44.63	—0.1	227,321	216,281	57.6	54.9	71.5	3,948	+ 1,540	5.509	1,252,254	16,400	1,268,654		88	
18	41.4	44.68	0.0	229,555	218,317	58.1	55.4	72.5	3,948	+ 2,036	5.652	1,297,510	17,900	1,315,410		89	X.—Brisk to strong.
a. m. 19 / p. m. 19†	41.4	44.58	0.0	227,032	216,189	57.5	54.9	71.5	3,948	— 2,128	5.636 / 5.515	1,279,456 / 1,252,114	18,600	1,298,056		78	VIII to X.—Light to brisk.
20	41.4	44.58	0.0	228,794	217,951	58.0	55.3	72.0	3,948	+ 1,762	5.649	1,292,369	19,300	1,311,669		91	XI.—Light.
21	41.5	44.66	+0.1	229,962	218,803	58.2	55.6	72.0	3,948	+ 852	5.745	1,321,116	20,100	1,341,216		76	IX.—Fresh.
24	41.6	44.71	0.0	232,956	221,600	59.0	56.3	74.0	3,948	+ 2,797	5.662	1,319,048	22,200	1,341,248		85	VIII.—Brisk.
25	44.6	44.78	0.0	231,659	220,027	58.7	55.9	74.0	3,948	— 1,573	5.445	1,261,442	22,900	1,284,342		93	VII.—Light.

[Datum line taken at water surface at section June 28, which is approximately 165.2 feet above the Cairo datum plane.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Arkansas City.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
June 28	46.9	.....	—0.4	222,612	222,612	54.9	54.9	68.5	4,054	.....	5.805	*1,292,347	5,828	1,298,175	14	58	
29	46.6	.....	—0.6	224,686	225,902	55.4	55.7	70.0	4,054	+3,290	5.592	*1,256,538	5,828	1,262,366	14	57	
29	46.51	.....	—0.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡5,828	.....	7	21	
30†	46.07	.....	—0.5	217,669	221,034	53.7	54.5	68.0	4,054	—4,868	4.778	‡1,039,943	5,828	1,045,771	14	61	IX.
30§	45.97	.....	—0.5	.....	.....	.....	.....	.....	.....	.....	4.866	‡1,059,170	5,828	1,064,998	13	.....	
July 1	45.38	.....	—0.7	219,464	225,626	54.1	55.7	68.0	4,054	+4,592	4.646	‡1,019,530	5,828	1,025,358	14	57	XII—Light.
1	45.33	.....	—0.7	.....	.....	.....	.....	.....	.....	.....	4.879	‖1,070,856	5,828	1,076,684	14	.....	
2	44.56	.....	—0.6	209,995	219,481	51.8	54.1	66.5	4,054	—6,145	5.259	*1,104,287	5,828	1,110,115	14	61	Some wind.
2	44.56	.....	—0.6	.....	.....	.....	.....	.....	.....	.....	4.891	‡1,027,161	5,828	1,032,989	14	.....	

* Meter No. 38. † A. m. ‡ Meter No. 39. § P. m. ‖ Double floats.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.

[Datum line taken at 41.73′ on Arkansas City gauge. Velocities taken with meter except for discharges marked thus *, when double floats were used.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.			Width.								
	Arkansas City.	Local	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
Apr. 22*	46.00	.....	+0.4	225,270	209,918	65.2	61.5	88.0	3,453	.....	5.807	1,308,146	2,376	1,310,522	12	48	
23*	46.35	.....	+0.2	241,132	224,579	69.8	65.7	91.0	3,453	+14,661	6.002	1,447,253	2,675	1,449,928	12	48	
25	46.90	.....	+0.1	239,831	221,389	69.5	64.8	93.0	3,453	− 3,190	5.761	1,381,748	3,274	1,385,022	12	48	
26	47.07	.....	+0.2	247,044	228,010	71.5	66.7	93.0	3,455	+ 6,621	6.161	1,521,971	3,663	1,525,634	12	50	
27	47.25	.....	+0.1	246,354	226,702	71.3	66.4	95.0	3,455	− 1,308	6.468	1,593,377	4,052	1,597,429	12	47	Windy.
28	47.45	.....	+0.3	248,870	228,514	71.9	66.9	95.0	3,461	+ 1,812	6.109	1,520,396	4,441	1,524,837	12	56	
29	47.61	.....	+0.2	251,600	230,094	72.7	67.5	95.0	3,461	+ 2,180	6.128	1,541,833	4,830	1,546,663	12	54	Downstream. Strong.
30	47.78	.....	0.0	252,906	231,415	73.1	67.7	95.0	3,461	+ 721	6.256	1,582,280	5,219	1,587,499	12	55	
May 2	47.96	.....	+0.1	246,564	224,454	71.2	65.7	95.0	3,461	− 6,961	6.564	1,618,559	5,997	1,624,556	12	51	Upstream.
3	48.02	.....	+0.1	247,551	225,235	71.5	65.9	94.0	3,461	+ 781	6.166	1,526,488	6,387	1,532,875	12	49	
4‖	48.10	.....	0.0	246,407	223,816	71.2	65.5	95.0	3,461	− 1,419	7.009	1,727,117	6,559	1,733,676	12	52	
4‖	48.10	.....	0.0	.....	.....	.....	.....	.....	.....	.....	7.041	1,734,967	6,559	1,741,526	12	.....	
5	48.25	.....	+0.1	248,712	225,605	71.9	66.0	93.0	3,461	+ 1,789	6.363	1,582,441	6,731	1,589,172	12	52	Light.
6	48.33	.....	+0.2	247,726	224,344	71.6	65.7	95.0	3,461	− 1,261	6.625	1,641,266	6,871	1,648,137	12	52	Calm.
7	48.55	.....	+0.1	247,198	223,059	71.4	65.3	95.0	3,461	− 1,285	6.500	1,606,703	7,011	1,613,714	12	52	
9	48.75	.....	0.0	249,627	224,801	72.1	65.8	95.0	3,461	+ 1,742	6.621	1,652,706	7,291	1,659,997	12	50	High.
10	48.80	.....	0.0	247,249	222,251	71.4	65.1	94.9	3,461	− 2,550	6.447	1,594,066	7,431	1,601,497	12	51	High to light.
11	48.88	.....	+0.2	248,656	223,383	71.8	65.4	95.5	3,461	+ 1,132	5.975	1,485,630	7,571	1,493,201	12	51	Light.
12	48.95	.....	0.0	249,755	224,241	72.2	65.6	94.5	3,461	+ 858	6.200	1,548,413	7,652	1,556,065	12	50	
13	49.14	.....	+0.2	248,170	222,093	71.7	65.6	95.5	3,461	− 2,238	5.879	1,458,873	7,733	1,466,606	12	51	
14	49.14	.....	0.0	243,345	217,178	70.3	63.6	95.0	3,461	− 4,825	5.761	1,401,997	7,814	1,409,811	12	51	Slight.
16	49.10	.....	0.0	250,912	224,882	72.5	65.8	96.0	3,461	+ 7,704	5.756	*1,444,252	7,976	1,452,228	12	50	
19	49.15	.....	0.0	251,441	225,239	72.6	65.9	95.5	3,461	+ 357	5.793	1,456,502	8,221	1,464,723	12	51	
21	49.27	.....	+0.1	247,559	220,945	71.5	64.7	90.	3,461	−4,294	5.647	1,397,985	8,317	1,406,302		50	Slight.
23	49.40	.....	+0.1	250,968	223,907	72.5	65.5	96.	3,461	+2,962	5.685	1,426,841	8,413	1,435,254		51	
23	49.40	.....	+0.1	.....	.....	.....	.....	.....	.....	.....	5.843	*1,466,317	8,413	1,474,730		...	
24	49.46	.....	0.0	247,954	220,687	71.6	64.6	95.5	3,461	−3,220	5.708	1,415,237	8,461	1,423,698		51	
26	49.59	.....	+0.1	251,889	224,175	72.8	65.6	97	3,461	+3,488	5.701	1,436,119	8,557	1,444,676		51	Light.
27	49.64	.....	+0.1	250,857	222,971	72.5	65.3	96	3,461	−1,204	5.661	1,420,014	8,605	1,428,619		51	Calm.
28	49.73	.....	0.0	250,868	222,672	72.5	65.2	96	3,461	− 299	5.730	1,437,497	8,653	1,446,150		50	High.
30	49.82	.....	0.0	249,698	221,193	72.1	64.7	96	3,461	−1,479	5.735	1,432,000	8,749	1,440,749		49	Calm to brisk.
31	49.82	.....	0.0	248,349	219,844	71.8	64.4	94.5	3,461	−1,349	5.945	1,476,534	8,796	1,485,330		52	Very strong.
June 1	49.88	.....	+0.1	251,289	222,577	72.6	65.2	95.5	3,461	+2,733	5.876	1,476,603	8,743	1,485,346		51	Calm.
3	49.73	.....	−0.1	246,607	218,411	71.3	63.9	94	3,461	−4,166	5.952	1,467,892	8,639	1,476,531		52	West.—Light.
4	49.60	.....	−0.1	245,821	218,072	71.0	63.8	92	3,461	− 339			8,587	1,452,325		57	

6	49.47	.....	0.0	243,470	216,168	40.3	63.3	91	3,461	—1,904	5.781	1,407,409	8,483	1,415,892		56	South.—Light.
7	49.43	.....	—0.1	251,458	224,294	72.7	65.7	96	3,461	+8,126	5.786	1,454,910	8,431	1,463,341		62	
8	49.39	.....	0.0	251,761	224,734	72.7	65.8	95	3,461	+ 440	5.784	1,456,230	8,379	1,464,609		68	Light.
9	49.39	.....	0.0	254,831	227,804	73.6	66.7	96	3,461	+3,070	5.790	1,475,400	8,327	1,483,727		61	
10	49.42	.....	0.0	253,040	225,910	73.1	66.1	94	3,461	—1,894	5.822	1,473,122	8,275	1,481,397		63	South.—Light.
11	49.44	.....	0.0	253,347	226,148	73.2	66.2	95.5	3,461	+ 238	5.788	1,453,676	8,178	1,461,854		60	Light.
13	49.45	.....	0.0	248,400	221,167	71.8	64.7	94	3,461	—4,981	5.811	1,443,467	7,990	1,451,457		66	SE.—Light.
14	49.45	.....	0.0	245,300	218,067	70.9	63.8	93	3,461	—3,100	5.862	1,437,988	7,897	1,445,885		74	E.—Light.
14	49.45	.....	0.0	§242,025	214,792	69.9	62.9	93	3,461	—3,275	5.848	1,415,298	7,897	1,423,195	12	46	Do.
15	49.44	.....	0.0	247,206	220,007	71.4	64.4	93.6	3,461	+5,215	5.663	1,399,935	7,804	1,407,739		70	
16	49.37	.....	0.0	250,563	223,605	72.4	65.5	93.5	3,461	+3,698	5.782	1,448,859	7,711	1,456,570		52	
17	49.30	.....	—0.1	249,433	222,716	72.1	65.2	95	3,461	— 889	5.727	1,428,398	7,618	1,436,016		53	
18	49.20	.....	—0.1	248,128	221,755	71.7	64.9	94	3,461	— 961	5.702	1,414,865	7,525	1,422,390		50	SW.—Fair.
20	48.97	.....	—0.2	249,278	223,695	72.0	65.5	93	3,461	+1,940	5.604	1,397,002	7,339	1,404,341		52	
20	48.97	.....	—0.2	.....	.....	.....	.....	.....	.....	.....	5.591	*1,393,709	7,339	1,401,048		...	
21	48.85	.....	0.0	247,190	222,020	71.4	65.0	92.5	3,461	—1,675	5.616	1,388,210	7,246	1,395,456		51	
21	48.85	.....	0.0	§240,414	215,244	69.5	63.0	90	3,461	—6,776	5.608	1,348,311	7,246	1,355,557		45	
22	48.62	.....	—0.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,153	.....		...	
23	48.47	.....	—0.2	245,642	221,779	71.0	64.9	94	3,461	+6,535	5.446	1,337,836	6,604	1,344,440		52	
24	48.28	.....	—0.2	246,258	223,048	71.2	65.3	92.5	3,461	+1,269	5.498	1,353,958	6,055	1,360,013		54	Up stream.—Strong.
27	47.52	.....	—0.2	240,268	219,671	69.4	64.3	90	3,461	—3,377	4.979	1,196,262	4,408	1,200,670		56	X.—Brisk.
28	47.17	.....	—0.4	244,949	225,556	70.8	66.0	92	3,461	+5,885	4.798	1,175,157	3,859	1,179,016		59	II.—Light.
29	46.65	.....	—0.6	244,007	226,401	70.5	66.3	92	3,461	+ 845	4.824	1,177,005	3,310	1,180,315		52	SW.—Slight.
30	46.13	.....	—0.5	236,632	220,833	68.5	64.6	89	3,453	—5,568	5.024	1,188,932	2,761	1,191,693		52	SW.—Upstream, strong.
30	46.13	.....	—0.5	.....	.....	.....	.....	.....	.....	.....	4.994	*1,181,689	2,761	1,184,450		...	
July 1	45.49	.....	—0.7	239,929	226,328	69.5	66.3	89	3,453	+5,405	4.819	1,156,144	2,212	1,158,356		53	
1	45.49	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.752	*1,140,130	2,212	1,142,342		...	

*Observations doubtful. †A. m. ‡P. m. §Piano wire soundings.

Result of discharge observations—Continued.

SIMMSPORT, LA. (ATCHAFALAYA RIVER).

[April 1 to May 7, datum line taken at 42′ .33; after that at 46′.64, as observed May 7 and June 24 on Simmsport gauge; velocities taken with meter.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.			Width.								
	Red River Landing.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
April *1	†31.15	.....	+0.2	48,439	59,658	50.9	56.5	71.9	951	.....	2.758	133,597	.....	.....	10	10	Upstream; light.
6	32.50	.....	+0.2	47,810	57,684	50.2	54.6	72.8	953	−1,974	2.947	140,882	.....	.....	10	10	From left bank; light
8	33.08	.....	+0.3	48,527	57,819	50.9	54.7	72.6	953	+ 135	3.036	147,309	.....	.....	10	10	Calm.
22	38.32	.....	+0.3	55,377	59,592	52.9	56.4	79.2	1,046	+1,773	3.648	202,017	.....	.....	11	11	Downstream; light.
May 2	41.45	.....	+0.2	57,485	58,414	54.5	55.3	80.8	1,055	−1,178	4.276	245,787	.....	.....	11	11	
7	42.33	.....	+0.2	58,522	58,522	55.4	55.4	83.8	1,056	+ 108	4.479	262,143	.....	.....	11	11	Calm.
‡13	43.18	.....	+0.1	56,433	60,270	53.7	49.3	85.0	1,050	.....	4.889	275,908	§895	.....	11	11	From left bank; light
20	43.60	.....	.....	59,366	62,761	56.5	51.4	86.8	1,051	+2,491	5.105	303,049	1,681	.....	11	11	Calm.
22	43.68	.....	.....	60,275	63,587	57.2	52.0	87.0	1,053	+826	4.927	296,983	1,642	.....	11	11	NW.—Strong.
24	43.76	.....	.....	59,647	62,875	56.5	51.5	86.5	1,055	−712	5.067	302,257	2,127	.....	11	11	S.—Light.
26	43.81	.....	.....	60,407	63,582	57.3	52.0	87.6	1,055	+707	4.958	299,479	2,137	.....	11	11	Calm.
28	43.90	.....	.....	59,996	63,076	56.9	51.6	87.5	1,055	−506	5.110	306,556	2,321	.....	11	11	SE.—Strong.
June 2	44.40	.....	.....	61,517	64,069	58.2	52.4	91.1	1,057	+993	5.254	323,230	2,739	.....	11	11	NW.
4	44.58	.....	.....	60,586	62,763	57.3	59.4	90.5	1,057	.....	5.295	320,812	3,175	.....	11	11	Calm.
6	44.82	.....	.....	60,659	62,583	57.4	59.2	91.1	1,057	−180	5.410	328,148	3,254	.....	11	11	Do.
8	45.02	.....	.....	61,227	62,939	57.9	59.5	91.7	1,057	+356	5.516	337,749	3,355	.....	11	11	Do.
10	45.28	.....	.....	61,356	62,794	58.0	59.4	90.1	1,057	−145	5.558	341,020	3,586	.....	11	11	Do.
13	45.77	.....	.....	62,452	63,372	59.1	60.0	91.6	1,057	+578	5.874	366,857	4,280	.....	11	11	SE.
15	46.10	.....	.....	62,964	63,536	59.6	60.1	91.4	1,057	+164	5.844	367,965	4,513	.....	11	11	Calm.
17	46.48	.....	.....	63,770	63,939	60.3	60.5	92.4	1,057	+403	6.279	400,442	5,006	.....	11	11	South.
19	46.60	.....	.....	64,207	64,249	60.7	60.8	94.2	1,057	+310	6.283	403,423	5,181	.....	11	11	NW.
21	46.60	.....	.....	64,026	64,068	60.6	60.6	92.4	1,057	−181	6.511	416,847	5,444	.....	11	11	Calm.
24	46.64	.....	.....	64,320	64,320	60.9	60.9	92.2	1,057	+252	7.005	450,561	6,449	.....	11	11	SW.
26	46.63	.....	.....	64,532	64,542	61.1	61.1	91.5	1,057	+222	6.981	450,557	6,543	.....	11	11	SW.—Light.
28	.....	.....	.....	63,424	.....	60.0	.....	90.8	1,057	.....	6.803	431,468	6,551	.....	11	11	North.

*April 1 to May 7, discharge section located between sill dams 1 and 2. † Simmsport gauge. ‡ New section. § Discharge of Alligator Bayou, which is shown on field sketch entering the Atchafalaya just below the new discharge section.

CARROLLTON, LA. (MISSISSIPPI RIVER.)

[Datum line taken at 17′ on Carrollton gauge, as observed June 10, 1899; velocities taken with meter.]

May	14	* 16.01	.....	—0.1	170,346	172,811	68.4	69.4	101.0	2,490	.....	6.147	1,047,052	.....	.....	15	15	Calm.
	16	16.15	.....	—0.1	172,740	174,856	69.4	70.2	102.8	2,490	+2,045	5.977	1,032,488	.....	.....	15	15	Do.
	18	16.25	.....	+0.2	176,130	177,988	70.7	71.5	103.0	2,490	+3,132	6.150	1,083,185	.....	.....	15	15	Do.
	19	16.10	.....	—0.2	176,616	178,857	70.9	71.8	102.8	2,490	+ 869	6.288	1,110,552	.....	.....	15	15	Do.
	21	16.30	.....	+0.3	174,085	175,828	69.9	70.6	103.0	2,490	—3,029	6.086	1,059,461	.....	.....	15	15	Do.
	24	16.30	.....	0.0	176,911	178,654	71.0	71.7	102.0	2,490	+2,826	5.961	1,054,638	.....	.....	15	15	Do.
	27	16.25	.....	—0.1	174,695	176,563	70.2	70.9	100.0	2,490	—2,091	5.988	1,046,113	.....	.....	15	15	Do.
June	1	16.50	.....	0.0	176,975	178,220	71.1	71.6	100.0	2,490	+1,657	5.968	1,056,172	.....	.....	15	15	Upstream; strong.
	4	16.60	.....	—0.2	179,418	180,414	72.1	72.5	104.0	2,490	+2,194	6.080	1,090,945	.....	.....	15	15	Calm.
	6	16.70	.....	—0.1	184 605	185,152	74.1	74.4	105.0	2,490	+4,738	5.891	1,087,508	.....	.....	15	15	Do.
	8	16.70	.....	0.0	184,215	184,962	74.0	74.3	104.0	2,490	— 190	6.083	1,120,583	.....	.....	15	15	Do.
	10	17.00	.....	+0.1	183,804	183,804	73.8	73.8	104.5	2,490	—1,158	5.872	1,079,260	.....	.....	15	15	Do.
	14	16.70	.....	—0.5	184,777	185,524	74.2	74.5	104.0	2,490	+1,720	5.908	1,091,708	.....	.....	15	15	NE.—Strong.
	17	16.10	.....	—0.1	182,332	184,573	73.2	74.1	103.0	2,490	— 951	5.764	1,050,884	.....	.....	15	15	Calm.
	20	16.10	.....	+0.1	180,126	182,367	72.3	73.2	103.0	2,490	—2,206	5.709	1,028.404	.....	.....	15	15	NE.—Light.
	24	15.90	.....	—0.1	175,534	178,273	70.5	71.6	102.0	2,490	—4,094	5.814	1,020,587	.....	.....	15	15	Calm.
	30	15.50	.....	—0.1	172,815	176,550	69.4	70.9	101.0	2,490	—1,723	5.652	976,785	.....	.....	15	15	Do.

*Carrollton gauge.

Results of discharge observations, Mississippi River and tributaries.

LITTLE ROCK, ARK. (ARKANSAS RIVER).

[Areas based on soundings made by Capt. Taber in January, 1892; the mean of four cross sections within limits of distance traveled by floats is taken for discharge section.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Little Rock.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. Feet.*	*Feet.*	*Cu. feet.*	*Cu. Ft.*	*Cu. feet.*			
May 23	30.	26.7	.....	37,710	.....	25.4	.....	.....	1,487	.....	12.107	456,565	.....	.....	6	41	Calm.
24	29.4	26.2	—0.8	36,962	.....	24.9	.....	.....	1,484	.....	11.115	410,829	.....	.....	5	41	IX—Medium.

MONROE, LA. (OUACHITA RIVER).

[Velocities taken with double floats.]

May 30	*37.5	37.48	.....	24,835	.....	31.0	.....	42.0	800	.....	.....	.....	.....	.....	(‡)	36	VI—Strong.
31	37.6	37.55	+0.1	†24,891	.....	31.1	.....	.....	800	.....	2.217	50,180	.....	.....	14	36	Do.
June 1	37.8	37.78	+0.2	†25,075	.....	31.3	.....	.....	800	.....	2.241	56,182	.....	.....	7	36	Calm.

* Monroe gauge. † Based on soundings of May 30, corrected for change of stage. ‡ Wind too strong for floats.

RED RIVER LANDING, LA.

Discharge section approximately same as former years. Datum line taken at 48'.85 on Red River Landing gauge, as observed June 27; velocity taken with meter.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Red River Landing.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.								
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
April 3	33.50	.....	+0.3	166,237	227,484	42.3	56.2	78.5	3,934	.....	4.424	735,437	.....	.....	20	20	Upstream; strong.
5	34.21	.....	+0.3	168,673	227,089	42.9	56.1	78.9	3,934	— 395	4.616	778,583	.....	.....	20	20	Upstream; light.
7	34.96	.....	+0.4	171,261	226,673	43.5	56.0	80.9	3,937	— 416	4.701	804,886	.....	.....	20	20	From right bank; light.
21	40.80	.....	+0.5	192,565	224,809	48.6	55.6	85.0	3,965	—1,864	5.204	1,002,108	.....	.....	21	21	Calm.
May 4	43.78	.....	+0.2	199,645	219,993	50.1	54.4	87.5	3,981	—4,816	5.422	1,082,434	.....	.....	21	21	Upstream; light.
6	44.09	.....	+0.2	201,689	220,793	50.7	54.6	86.8	3,981	+ 800	5.413	1,091,754	.....	.....	21	21	Do.
11	44.79	.....	+0.1	205,926	222,523	51.7	54.9	87.7	3,982	+1,430	5.423	1,116,746	.....	.....	21	21	From left bank; light.
19	45.36	.....	+0.1	207,585	221,695	51.4	54.8	86.2	4,010	— 528	5.444	1,130,079	1,826	1,131,905	22	22	
21	45.40	.....	0.0	208,424	222,372	51.6	55.0	87.0	4,040	+ 677	5.432	1,132,059	2,567	1,134,626	22	22	N.—Strong.
23	45.45	.....	0.0	208,835	222,581	51.7	55.0	89.6	4,040	+ 209	5.339	1,115,016	4,438	1,119,454	22	22	Calm.
25	45.50	.....	0.0	210,393	223,949	52.1	55.3	88.7	4,041	+1,358	5.402	1,136,506	5,500	1,142,006	22	22	Upstream.
27	45.60	.....	+0.1	211,731	224,872	52.4	55.6	88.1	4,041	+ 933	5.384	1,139,957	5,593	1,145,550	22	22	SW.—Light.
June 1	45.96	.....	+0.1	212,807	224,554	52.7	55.5	88.6	4,042	— 318	5.369	1,149,293	5,784	1,155,077	22	22	SE.
3	46.12	.....	+0.1	211,275	222,316	52.3	54.9	87.4	4,043	—2,238	5.370	1,134,529	6,800	1,141,329	22	22	NW.
7	46.50	.....	+0.1	214,122	223,628	52.9	55.3	86.6	4,044	+1,312	5.381	1,152,115	7,265	1,159,380	22	22	Calm.
9	46.70	.....	+0.1	219,662	228,359	54.3	56.4	88.2	4,044	+4,731	5.325	1,169,709	7,097	1,176,806	22	22	Do.
11	46.95	.....	+0.1	222,392	230,078	55.0	56.9	87.7	4,044	+1,719	5.311	1,181,173	6,851	1,188,024	22	22	SE.
14	47.45	.....	+0.2	226,525	232,188	56.0	57.4	88.9	4,044	+2,110	5.357	1,213,409	7,500	1,220,909	22	22	South.
16	47.70	.....	+0.1	229,669	234,321	56.8	57.9	89.2	4,044	+2,133	5.450	1,251,768	8,201	1,259,969	22	22	NE.—Light.
20	48.22	.....	+0.1	229,575	232,124	56.8	57.4	89.6	4,045	—2,197	5.571	1,279,044	8,875	1,287,919	22	22	NW.
23	48.60	.....	+0.1	231,371	232,382	57.2	57.4	90.0	4,045	+ 258	5.636	1,303,913	8,332	1,312,245	22	22	SW.
25	48.70	.....	+0.1	229,694	230,301	56.8	56.9	91.0	4,045	—2,081	5.768	1,324,916	9,481	1,334,397	22	22	West.
27	48.85	.....	0.0	228,594	228,594	56.5	56.5	91.0	4,046	—1,707	5.779	1,321,011	9,577	1,330,588	22	22	South.

Slope observations, Mississippi River.

COLUMBUS, KY.

Distances between gauges 8 400 feet. [Results of reduction at office of first and second districts engineer.]

1892.	Belmont gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.
	Feet.	*Feet.*	*Feet.*	
April 13	41.28			
15	41.20			.0001024
16	41.00			
26	42.96	9.488	8.833	0988
27	43.00	9.141	8.833	0976
28	43.10	9.527	9.064	0976
29	43.10	9.874	9.103	0976
30	42.88	9.565	9.103	1012

FULTON, TENN.

[Results of reduction at office of first and second districts engineer.]

1892.	Fulton gauge.	Maximum surface velocity at Craighead, per second.	Maximum surface velocity at Falls Landing, per second.	Slope sine of inclination.	
				Between Craighead and Section.	Between Section and Falls gauge.
	Feet.	*Feet.*	*Feet.*		
April 15	32.94		7.69	.0002441	.0003374
16	33.10	7.69	8.00	2393	0424
18	33.21	7.14	8.33	2374	0484
19	33.25	8.00	8.00	2422	0454
21	33.38	8.00	8.00	2403	0444
22	33.35	7.69	8.33	2346	0443
23	33.37	7.41	8.70	2355	0464
25	33.50	7.14	9.09	2441	0444
26	33.63	7.14	8.00	2441	0474
27	33.81	7.14	8.33	2470	0444
28	33.96	8.33	8.00	2489	0444
29	34.03	8.00	8.70	2393	0504
30	34.22	7.41	8.00	2403	0484
May 2	34.21	7.14	7.69	2422	0504
3	34.18	7.41	7.69	2384	0494

NOTE.—Gauge B is at discharge section. Craighead gauge is 10,500 feet above, and Falls gauge 9,000 feet below gauge B. The river is nearly straight from 1,000 feet below Craighead gauge to Falls gauge. The slope of river around Craighead point in vicinity of gauge was 1 foot on 600 feet. Sine—about 0.00167.

Slope observations, Mississippi River.—Continued.

HELENA, ARK.

Distance between gauges 12,570 feet. [Results of reduction at office of first and second districts engineer.]

1892.	Helena gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.	1892.	Helena gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.
	Feet.	*Feet.*	*Feet.*			*Feet.*	*Feet.*	*Feet.*	
April 18	42.60				June 2	44.70	7.139	8.448	.000684
19	42.73	6.714	8.216	.0000708	3	44.66	7.060	8.294	0684
20	42.87				4	44.61	7.060	8.178	0692
21	43.25	7.368	8.718	0708	6	44.56	6.984	7.630	0692
May 3	44.50	7.368	8.987	0637	7	44.60	7.023	7.677	0700
4	44.64	7.137	8.486	0660	8	44.62	7.176	8.409	0700
5	44.77	7.677	9.103	0676	9	44.72	7.060	8.756	0708
6	44.88	7.368	9.218	0637	10	44.77	7.003	8.062	0708
7	44.98	7.291	9.218	0644	11	44.86	6.800	8.486	0708
9	45.48	7.754	8.910	0637	13	45.00	6.834	8.332	0716
10	45.66	7.484	9.103	0605	14	45.06	7.047	9.180	0708
11	45.73	7.985	9.450	0605	15	45.11	7.835	8.332	0708
12	45.69	7.638	9.064	0621	16	45.12	7.947	8.525	0708
13	45.51	7.754	9.257	0605	17	45.06	7.600	8.139	0716
14	45.26	7.561	9.296	0668	18	45.00	7.409	7.831	0708
16	44.77	7.638	9.604	0684	20	44.82	7.038	8.679	0660
17	44.55	7.600	9.450	0692	21	44.63	7.137	8.255	0660
June 1	44.67	7.291	8.872	0692	22	44.45	6.946	8.409	0676

ARKANSAS CITY, ARK.

[From reduction at office of third district engineer.]

1892.	Arkansas City gauge.	Slope sine of inclination.		1892.	Arkansas City gauge.	Slope sine of inclination.	
		Above.	Below.			Above	Below.
	Feet.				*Feet.*		
Apr. 23	46.35		.0000645	May 31	49.82	.0000600	.0000642
25	46.90		638	June 1	49.88	595	642
26	47.07		635	3	49.73	591	643
27	47.25		631	3	49.73	591	643
28	47.45	.0000562	629	4	49.60	594	642
29	47.61	566	629	4		594	
30	47.78	550	627	6	49.47	587	644
May 2	47.96	552	624	7	49.43	591	647
3	48.02	556	620	8	49.39	594	645
4	48.10	557	620	9	49.39	594	645
4	48.10	557	620	10	49.42	593	646
5	48.25	553	620	11	49.44	590	647
6	48.33	564	615	13	49.45	589	647
7	48.55	553	618	14	49.45	589	647
9	48.75	544	620	14	49.45	589	
10	48.80	549	620	15	49.44	590	646
11	48.88	550	624	16	49.37	587	649
12	48.95	562	623	17	49.30	585	646
13	49.14	563	624	18	49.20	585	646
14	49.14	573	624	20	48.97	579	647
14	49.14	573	624	20	48.97	579	647
16	49.10	585	632	21	48.85	571	646
19	49.15	580	634	21	48.85	571	
21	49.27	579	645	23	48.47	569	649
23	49.40	585	638	24	48.28		647
23	49.40	585	638	27	47.52		651
24	49.46	581	638	28	47.17		651
26	49.59	577	639	29	46.65		651
27	49.64	581	644	30	46.13		652
28	49.73	582	643	30	46.13		
30	49.82	593	642	July 1	45.49		638
30	49.82	593	642	1	45.49		638

NOTE.—The slope obtained by taking for the "above," the gauge at Bolivar Landing and Arkansas City, and for the "below," the gauges at Arkansas City and Greenville, and the distance as 216000 feet. And the slopes are given in decimals of a foot; being the fall per foot.

Results of discharge observations, Mississippi River and tributaries.

LITTLE ROCK, ARK. (ARKANSAS RIVER).

[Areas based on soundings made by Capt. Taber in January, 1892; the mean of four cross sections within limits of distance traveled by floats is taken for discharge section.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Little Rock.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. Feet.*	*Feet.*	*Cu. feet.*	*Cu. Ft.*	*Cu. feet.*			
May 23	30.	26.7	.....	37,710	.....	25.4	.....	.....	1,487	.....	12.107	456,565	.....	.....	6	41	Calm.
24	29.4	26.2	—0.8	36,962	.....	24.9	.....	.....	1,484	.....	11.115	410,829	.....	.....	5	41	IX—Medium.

MONROE, LA. (OUACHITA RIVER).

[Velocities taken with double floats.]

May 30	*37.5	37.48	.....	24,835	.....	31.0	.....	42.0	800	.....	.....	.....	.....	.....	(‡)	36	VI—Strong.
31	37.6	37.55	+0.1	†24,891	.....	31.1	.....	.....	800	.....	2.217	50,180	.....	.....	14	36	Do.
June 1	37.8	37.78	+0.2	†25,075	.....	31.3	.....	.....	800	.....	2.241	56,182	.....	.....	7	36	Calm.

* Monroe gauge. † Based on soundings of May 30, corrected for change of stage. ‡ Wind too strong for floats.

Slope observations, Mississippi River—Continued.

ALEXANDRIA, LA. (RED RIVER).

[Distance between upper and lower gauges, 4,000 feet.]

	Alexandria gauge.	Slope sine of inclination between upper and lower gauges.		Alexandria gauge.	Slope sine of inclination between upper and lower gauges.
1892.	*Feet.*		1892.	*Feet.*	
ay 27	29.5	.000450	June 7	37.5	.000475
28	30.6	050	8	37.8	500
30	33.2	450	9	37.8	500
31	33.7	450	10	37.9	450
ne 1	34.5	400	11	38.1	450
2	35.0	425	13	38.2	700
3	35.6	450	14	38.2	450
4	36.1	500	15	38.0	450
6	37.0				

Results of final reduction of rating observations with Price current meters.

No. of meter.	Date.	A.	B.	Mean error of observation.	Mean error of A.	Mean error of B.	No. of observations.	(*)	Length of base.	Limits of observed velocity.		Locality.
	1892.								Feet.	Feet per second.		
5	May 30	3.73306	+0.2900	±0.0841	±0.0439	±0.0648	16	S	200	3.2 to	9.1	Huntington Loop.
5	June 3	3.68321	+0.3920	0.0389	0.0209	0.0343	12	R	200	3.3	10.0	Do.
5	Weighted means	3.69243	+0.36970									
5	May 30	4.1852	−0.046	0.0812	0.1130	0.0518	24	S	200	0.8	2.8	Do.
5	June 3											
22	June 8	3.86543	+0.2847	0.0807	0.0182	0.0247	38	R	200	1.1	9.5	Company Canal.
23	July 12	4.0118	+0.2318	0.0968	0.0322	0.0450	18	R	200	1.0	9.2	Do.
25	do	4.0072	+0.2250	0.1377	0.0490	0.0472	30	R	200	1.0	9.6	Do.
38	May 4	3.96203	+0.3282	0.0867	0.0887	0.1186	16	R	400	3.1	7.5	Wilson Point.
38	May 11	3.81063	+0.5532	0.0429	0.0389	0.0525	12	R	400	3.1	8.0	Do.
38	May 26	3.91319	+0.396	0.0368	0.0267	0.0322	16	R	400	2.3	7.0	Do.
38	June 6	3.8545	+0.30646	0.0968	0.1071	0.2055	6	R	200	5.6	9.5	Huntington Loop.
38	June 8	3.83225	+0.3108	0.112	0.0643	0.1108	8	R	200	2.8	9.5	Do.
38	Weighted means	3.87894	+0.42477									
38	Nov. 26	4.41178	+0.0483	0.0585	0.0410	0.0289	22	R	200	0.6	5.4	Ashton.
38	May 4	4.20594	+0.1499	0.124	0.6598	0.2079	6	R	400	0.5	2.4	Wilson Point.
38	May 11	4.0882	+0.1466	0.0781	0.1229	0.0508	7	R	400	0.5	3.7	Do.
38	May 26	4.43242	−0.00565	0.0321	0.0063	0.0273	6	R	400	0.6	3.4	Do.
38	June 6	4.28415	−0.03195	0.0397	0.0555	0.0249	12	R	200	0.6	3.2	Huntington Loop.
38	June 8	4.28495	−0.0324	0.0447	0.0847	0.0317	10	R	200	0.6	2.9	Do.
38	Weighted means	4.31828	−0.00714									
39	April 23	3.57443	+0.7733	0.1137	0.0785	0.0354	13	S	200	3.4	7.7	Do.
39	April 29	3.60705	+0.7163	0.0898	0.0558	0.0720	20	S	200	3.4	7.7	Do.
39	May 9	3.76672	+0.5380	0.0967	0.0693	0.0936	13	S	200	3.8	8.7	Do.
39	May 12	3.79859	+0.4564	0.0656	0.0371	0.0534	18	S	200	3.7	8.7	Do.
39	May 23	3.72022	+0.4339	0.0770	0.0449	0.0601	13	S	200	3.1	8.7	Do.
39	July 12	3.66562	+0.5612	0.108	0.0719	0.0944	16	R	200	3.0	7.1	Below Chicot Point.
39	Weighted means	3.73111	+0.5185									
39	April 23	4.6000	−0.0217	0.1012	0.708	0.4186	6	S	200	2.1	2.9	Huntington Loop.
39	May 9 and 12	4.4118	−0.0013	0.0314	0.0726	0.0381	9	S	200	1.0	3.0	Do.
39	May 23	4.45161	+0.0045	0.0658	0.216	0.101	5	S	200	1.3	2.9	Do.
39	June 11	4.30412	−0.0008	0.0922	0.2228	0.1093	6	R	400	0.9	2.7	Wilson Point.
39	July 12	4.32156	+0.0571	0.0295	0.0395	0.0160	10	R	200	0.6	2.5	Below Chicot Point.
39	Weighted means	4.34402	+0.04658									

* "R" indicates observations in running water, and "S" in still water.

Slope observations, Mississippi River.—Continued.

HELENA, ARK.

tance between gauges 12,570 feet. [Results of reduction at office of first and second districts engineer.]

	Helena gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.
1892.	*Feet.*	*Feet.*	*Feet.*	
ril 18	42.60			
19	42.73	6.714	8.216	.0000708
20	42.87			
21	43.25	7.368	8.718	0708
y 3	44.50	7.368	8.987	0637
4	44.64	7.137	8.486	0660
5	44.77	7.677	9.103	0676
6	44.88	7.368	9.218	0637
7	44.98	7.291	9.218	0644
9	45.48	7.754	8.910	0637
10	45.66	7.484	9.103	0605
11	45.73	7.985	9.450	0605
12	45.69	7.638	9.064	0621
13	45.51	7.754	9.257	0605
14	45.26	7.561	9.296	0668
16	44.77	7.638	9.604	0684
17	44.55	7.600	9.450	0692
ne 1	44.67	7.291	8.872	0692
June 2	44.70	7.139	8.448	.000684
3	44.66	7.060	8.294	0684
4	44.61	7.060	8.178	0692
6	44.56	6.984	7.630	0692
7	44.60	7.023	7.677	0700
8	44.62	7.176	8.409	0700
9	44.72	7.060	8.756	0708
10	44.77	7.003	8.062	0708
11	44.86	6.800	8.486	0708
13	45.00	6.834	8.332	0716
14	45.06	7.947	9.180	0708
15	45.11	7.835	8.332	0708
16	45.12	7.947	8.525	0708
17	45.06	7.600	8.139	0716
18	45.00	7.409	7.831	0708
20	44.82	7.638	8.679	0660
21	44.63	7.137	8.255	0660
22	44.45	6.946	8.409	0676

ARKANSAS CITY, ARK.

[From reduction at office of third district engineer.]

	Arkansas City gauge.	Slope sine of inclination.	
		Above.	Below.
1892.	*Feet.*		
r. 23	46.35		.0000645
25	46.90		638
26	47.07		635
27	47.25		631
28	47.45	.0000562	629
29	47.61	566	629
30	47.78	559	627
y 2	47.96	552	624
3	48.02	556	620
4	48.10	557	620
4	48.10	557	620
5	48.25	553	620
6	48.33	564	615
7	48.35	553	618
9	48.75	544	620
10	48.80	549	620
11	48.88	550	624
12	48.95	562	623
13	49.14	563	624
14	49.14	573	624
14	49.14	573	624
16	49.10	585	632
19	49.15	580	634
21	49.27	579	635
23	49.40	585	638
23	49.40	585	638
24	49.46	581	638
26	49.59	577	639
27	49.64	581	644
28	49.73	582	643
30	49.82	593	642
30	49.82	593	642
May 31	49.82	.0000600	.0000642
June 1	49.88	595	642
3	49.73	591	643
3	49.73	591	643
4	49.60	594	642
4		594	
6	49.47	587	644
7	49.43	591	647
8	49.39	594	645
9	49.39	594	645
10	49.42	593	646
11	49.44	590	647
13	49.45	589	647
14	49.45	589	647
14	49.45	589	
15	49.44	590	646
16	49.37	587	649
17	49.30	585	646
18	49.20	585	646
20	48.97	579	647
20	48.97	579	647
21	48.85	571	646
21	48.85	571	
23	48.47	569	649
24	48.28		647
27	47.52		651
28	47.17		651
29	46.65		651
30	46.13		652
30	46.13		
July 1	45.49		638
1	45.49		638

NOTE.—The slope obtained by taking for the "above," the gauge at Bolivar Landing and Arkansas y, and for the "below," the gauges at Arkansas City and Greenville, and the distance as 216000 t. And the slopes are given in decimals of a foot; being the fall per foot.

Crevasse measurements.

[For notes on reduction, see p. 3678.]

MISSISSIPPI RIVER, THIRD DISTRICT.

Name.	Distance from Cairo.	Bank.	Width.	Discharge per second.	Date of break.	Date of observation.	Method.
	Miles.		*Feet.*	*Cubic feet.*	1892.	1892.	
Fulton Lake	439	Right.	1,666	*14,988	June 2	June 8	Meter No. 5.
Do	439	Right.	1,809	15,960	.....	June 18	Do.
Do	439	Right.	1,922	19,554	.....	June 22	Do.
Panther Forest	452	Right.	1,091	74,214	May 13	May 17	Meter No. 39.
Do	452	Right.	1,410	69,550	.....	May 25	Do.
Do	452	Right.	1,673	80,884	.....	June 2	Meter No. 38.
Do	452	Right.	2,085	91,623	.....	June 17	Do.
Columbia	470	Right.	380	†18,483	June 22	June 25	Meter No. 39.
Leland	484	Right.	312	†9,800	May 25	June 1	Surface floats.
Do	484	Right.	423	17,253	.....	June 16	Do.
Do	484	Right.	423	§6,935	.....	June 25	Meter No. 39.
Brooks Mill	506	Right.	668	†35,006	May 9	May 13	Surface floats.
Do	506	Right.	715	87,331	.....	June 9	Meter No. 39.
Do	506	Right.	715	80,093	.....	June 24	Do.

*Integration method.
†Meter at six-tenths depth.
‡Results of reduction at office of Third District Engineer.
§Meter 4 feet below surface.

Crevasse measurements.

[Results of reduction at office of Fourth District Engineer.]

MISSISSIPPI RIVER, FOURTH DISTRICT.

Name.	Distance below Cairo.	Bank.	Maximum width of crevasse.	Approximate maximum discharge per second.	Date of occurrence.	Date of closure.	Cause of crevas
	Miles.		*Feet.*	*Cubic feet.*	1892.	1892.	
Ascension	882.5	Right.	148	17,200	June 6	June 9	Crayfish hole.
Hermitage	886.5	Left..	63	9,500	June 21	June 23	Do.
New Hope	897	Right.	160	19,100	June 1	June 6	Do.
Delogny	906.5	Right.	126	16,400	June 23	June 28	Do.
Belmont	908	Left..	1,427	139,846	June 12	.....	Do.
Tessier	909.75	Left..	204	25,520	May 22	May 29	Do.
Anchor	929.6	Left..	396	21,000	May 6	.....	Unknown.
Sarpy	937	Left..	1,380	115,920	June 13	.....	Crayfish hole.
Avondale	952	Right.	139	16,120	June 13	June 19	Do.
Villere, No. 1	972	Left..	15	742	May 3	May 4	Do.
Villere, No. 2	971.9	Left..	124	1,816	June 11	.....	Do.
Story, No. 1	975	Left..	23	952	May 28	May 30	Do.
Story, No. 2	974.75	Left..	114	16,560	June 11	.....	Do.
Merritt	976.5	Left..	96	13,500	June 13	June 19	Do.
Belle Chasse	982.5	Right.	107	14,186	June 3	June 15	Do.
Cedar Grove	989.5	Right.	26	686	May 24	May 28	Old rice flume.
Belair	995	Left..	62	8,700	May 24	May 28	Crayfish hole.
Monsecour, No. 1	998.9	Left..	24	2,100	May 11	May 11	Do.
Monsecour, No. 2	999	Left..	26	2,280	May 29	June 4	Do.
Happy Point	993	Left..	51	6,750	May 18	May 28	Rice flume.
Mousecour, No. 3	999.1	Left..	37	2,785	June 7	June 18	Crayfish hole.
Harlem*	1,002.0 to 1,003.2	Left..	441	22,050	May 12 to June 10	May 15 to July 1	Muskrat, cr fish, and ri flume.
Miller	1,011.7	Left..	39	5,985	.....	June 14	Muskrat.
Octave	1,012.0	Left..	35	5,600	.....	May 14	Do.
Martin	1,013.5	Left..	194	3,492	.....	July 2	Caving bank.

*In a distance of 6,000 feet there were 11 breaks at Harlem, and figures presented are aggregates.

BAYOU LAFOURCHE.

Hill	.....	.....	145	.....	May 9	.....	
Upper Ten	.....	.....	40	.....	July 2	July 8	
Boudreaux	.....	.....	225	.....	Apr. 25	.....	

ATCHAFALAYA RIVER.

Philip White	.....	.....	6,000†	.....	June 16	.....	

†About.

APPENDIX 3 K.

STUDY OF EARLY MAPS OF MISSISSIPPI RIVER. BY CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

ST. LOUIS, MO., *June 9, 1893.*

GENERAL: I have the honor to present the result of a study of some early maps of the Mississippi River, as compared with those of the Commission.

The three maps herewith shown are:

(1) "Course of the River Mississippi, from the Balise to Fort Chartres. Taken on an expedition to the Illinois in the latter end of the year 1765. By Lieut. Ross, of the Thirty-fourth Regiment. Improved from the surveys of the river made by the French."

(2) "A draft of the Mississippi River from the Balise up to Fort Chartres," from a report to the secretary of state for the colonies, by Capt. Philip Pitman, published in London in 1770.

(3) "Map of the course of the Mississippi from the Missouri and the country of the Illinois to the mouth of the river," from the travels of Gen. Victor Collot, published in Paris in 1826.

Of Ross, directly, I have been able to learn nothing. Fort Chartres was turned over by its French commandant to the English commission on November 11, 1765.

For the privilege of tracing the map I am indebted to the Missouri Historical Society.

Pitman, for the reading of whose report and the privilege of tracing the map I am indebted to Col. George E. Leighton, of St. Louis, describes himself as having been employed in "those countries" for five years as an engineer. The only date mentioned in his report is 1768.

Collot, a young officer of the etat-major under Rochambeau in America, brigadier-general and governor of Guadaloupe under the Republic, prisoner of war and left in Philadelphia by the English in the winter of 1795–'96, was detained in this country by a lawsuit, and was, at his own suggestion, commissioned by Citizen Adet to explore the former French province of Louisiana. His book, in the hands of the printer at the time of his death, but not published till long after, shows great intelligence, acute observation, and a scrupulous accuracy in stating what he saw himself and what he reports from hearsay. He left St. Louis on September 16, 1796, in an open boat (pirogue) with one white assistant and four Indians, and reached three leagues above New Orleans, when he was arrested as a spy by Baron Carondelet, on October 26.

Of the three, Pitman has the largest scale and the fullest detail, and is most convenient for comparison. Ross is very noteworthy for the accuracy of his topographical eye and his rendering of characteristic outlines. Collot has the best general alignment. I regard them all as topographical reconnoissances, probably platted by compass bearings and estimated distances, and from the general goodness of their latitudes, probably checked by altitudes of Polaris. The later forms of astrolabe or the single reflecting sextant would have made this practicable. It is almost needless to state that the longitudes are all bad.

For comparison of the three, I have selected a series of clearly recognizable points giving a meander line of the general course of the river, platted them directly from Collot's map, which is on smaller scale, and constructed the others by offsets from the straight line, Cairo–New Orleans. The results are shown on the accompanying plat.

For the course of the river, I have collated the old maps with the "Alluvial Valley," looking for details to the inch-mile series, and occasionally even to the contour lines of the detail charts. By the topography surveyed about 1880, I find, from Cairo to Donaldsonville, the river bed of 1765 recognizable in the present bed, the cut-off lakes, the lines of bayous, sloughs, and creeks, the belts of swamp, the depressions as shown by the contour lines, and the lines of levee following old banks because of their altitude. In making this comparison I have derived some little aid from the reconnoissance of 1821 by Young, Poussin, and Tuttle, and much more from the "Navigator," edition of 1817, a pilot's guide describing the channels by reference to points and islands.

As regards the shortening of the bed by cut-offs, it is noticeable that, from 1765 to 1796, there is no change of this character. Since 1800 there has been no such period of thirty-one years. Four cut-offs, whose dates are undetermined, occurred between 1796 and 1817—the Montezuma Bend, Grand Lake, Yazoo, and Homochitta. The "Navigator" mentions the old beds at Grand Lake and the Yazoo Bend as filled, and overgrown, but recognizable by the smaller willows therein. The others are not referred to. Humphreys and Abbot, in their summary of tradition of early floods,

Results of final reduction of rating observations with Price current meters.

No. of meter.	Date.	A.	B.	Mean error of observation.	Mean error of A.	Mean error of B.	No. of observations.	(*)	Length of base.	Limits of observed velocity.		Locality.
	1892.								*Feet.*	*Feet per second.*		
5	May 30	3.73306	+0.2900	±0.0841	±0.0439	±0.0648	16	S	200	3.2 to	9.1	Huntington Loop.
5	June 3	3.68321	+0.3920	0.0389	0.0209	0.0343	12	R	200	3.3	10.0	Do.
5	Weighted means	3.69243	+0.30970									
5	May 30	4.1852	−0.046	0.0812	0.1130	0.0518	24	S	200	0.8	2.8	Do.
5	June 3											
22	June 8	3.86543	+0.2847	0.0807	0.0182	0.0247	38	R	200	1.1	9.5	Company Canal.
23	July 12	4.0118	+0.2318	0.0868	0.0322	0.0450	18	R	200	1.0	9.2	Do.
25	do	4.0072	+0.2250	0.1377	0.0496	0.0472	30	R	200	1.0	9.6	Do.
38	May 4	3.96203	+0.3282	0.0867	0.0887	0.1186	16	R	400	3.1	7.5	Wilson Point.
38	May 11	3.81063	+0.5532	0.0429	0.0389	0.0525	12	R	400	3.1	8.0	Do.
38	May 26	3.91319	+0.396	0.0368	0.0267	0.0322	16	R	400	2.2	7.0	Do.
38	June 6	3.8545	+0.30646	0.0968	0.1071	0.2475	6	R	200	5.6	9.5	Huntington Loop.
38	June 8	3.83225	+0.3108	0.112	0.0643	0.1108	8	R	200	2.8	9.5	Do.
38	Weighted means	3.87894	+0.42477									
38	Nov. 26	4.41178	+0.0483	0.0585	0.0410	0.0289	22	R	200	0.6	5.4	Ashton.
38	May 4	4.20594	+0.1499	0.124	0.6598	0.2099	6	R	400	0.5	2.4	Wilson Point.
38	May 11	4.0882	+0.1466	0.0781	0.1220	0.0568	7	R	400	0.5	3.7	Do.
38	May 26	4.43242	−0.00565	0.0321	0.0683	0.0273	6	R	400	0.6	3.4	Do.
38	June 6	4.28415	−0.03195	0.0397	0.0555	0.0249	12	R	200	0.6	3.2	Huntington Loop.
38	June 8	4.28495	−0.0324	0.0447	0.0847	0.0317	10	R	200	0.6	2.9	Do.
38	Weighted means	4.31828	−0.00714									
39	April 23	3.57443	+0.7733	0.1137	0.0785	0.0354	13	S	200	3.4	7.7	Do.
39	April 29	3.60705	+0.7163	0.0898	0.0558	0.0720	20	S	200	3.4	7.7	Do.
39	May 9	3.76672	+0.5380	0.0467	0.0673	0.0936	13	S	200	3.8	8.7	Do.
39	May 12	3.79859	+0.4564	0.0656	0.0471	0.0514	18	S	200	3.7	8.7	Do.
39	May 23	3.72022	+0.4339	0.0770	0.0419	0.0601	13	S	200	3.1	8.7	Do.
39	July 12	3.66562	+0.5612	0.108	0.0719	0.0944	16	R	200	3.0	7.1	Below Chicot Point.
39	Weighted means	3.73111	+0.5185									
39	April 23	4.6000	−0.0217	0.1012	0.7[illegible]8	0.4186	6	S	200	2.1	2.9	Huntington Loop.
39	May 9 and 12	4.4118	−0.0013	0.0314	0.0726	0.0[illegible]81	9	S	200	1.0	3.0	Do.
39	May 23	4.45161	+0.0045	0.0658	0.216	0.101	5	S	200	1.3	2.9	Do.
39	June 11	4.30412	−0.0908	0.0922	0.2228	0.1093	6	R	400	0.9	2.7	Wilson Point.
39	July 12	4.32156	+0.0571	0.0235	0.0395	0.0160	10	R	200	0.6	2.5	Below Chicot Point.
39	Weighted means	4.34402	+0.04658									

* "R" indicates observations in running water, and "S" in still water.

land back of the towhead of Island 25, Daniels Point, and Keyes Point, appear to be of the old bank, and a bend in the left bank like that around islands 26 and 27 is recognized. The reach is full of islands called the "Canadian," having only a general resemblance to the present chain.

6. Plum Point appears to extend out to Osceola Bar. Bending around it the river cuts more than now into its right bank, dividing equally around Island 33, and meeting the bluffs higher up than now. Island No. 34 shows broader at its lower end, coming into line with Morgans Point; the river divides about equally around No. 34, and strikes the second bluffs higher up than now, leaving small islands in the bend. The next bend with Island 35 is as now except that the channels are nearly equal.

7. Below Cedar Point the river bends well back to the cliffs (indicated on all the maps) around Island 36, then around a point apparently extending beyond Deans Island and separated from No. 36 by a narrow chute (now the main river), around the chute of 37 (shown as a double island) and of 38 (now continuous with the right bank), across the lower end of Centennial Island and upper end of Brandywine Island, where depressions now show, and along the lines of Berkeley Bayou and Bear Creek, dividing equally around No. 40, receiving the Loosahatchie as an independent tributary, having a very broad reach with islands where is now the bend above Memphis, and meeting the Wolf River at its emergence from the bluffs.

8. Below Memphis the characteristic shapes of Presidents Island and its common (46 and 45) are very recognizable, especially in Ross. From Presidents Island to Commerce, the maps show a difference which may be of stage. All have the right bank nearly as now, but following the chute of Cat Island; all show islands 47 and 48, Cat Island, and No. 53 (much larger than now); Pitman marks the two ends of the Horseshoe Lake. On the left bank, Ross's line merely cuts off the point which would be rounded in passing down out of Tennessee chute, while Pitman's would indicate overflow back to the bluffs and down to Horn Lake. Collot, with less detail, agrees more nearly with Pitman.

9. Continuing against the high land above Commerce, the river passes around the Council Bend (cut-off in 1874), in which all the maps show an island cut off from Linwood Point, then around through the sloughs and Old River Lake, against the old line of levee. Ashley Point would appear to have extended to Clarks tow-head, and to have a considerable island cut off from it. The river then passes around Walnut Bend, with an island in about the position of Whiskey Island, but not especially resembling it in shape, and around Hardins Point, cutting more into its left bank than now; the maps show islands not resembling the present ones.

10. Harberts Point shows an island cut-off by a narrow chute near the present line of levee, and this bend cuts more deeply into its right bank than now. From the mouth of the St. Francis the river cut more into its left bank than now, nearly against the line of levee, leaving an island near the present No. 60, a point at Trotters Landing, and then probably through the Swampy Eagle Lake. (I place the river so far east just here, partly because of the lines of the maps, and partly because neither Ross nor Collot, who usually represents the bluffs, have any notes of those near Helena.) Then through Hubbard Lake, around through Moon Lake (in which Texas and Alcorn Islands are especially well drawn by Ross), crossing its present bed as far as Willow Lake, and around through Horseshoe Lake. (The Horseshoe cut-off is of 1848; the Montezuma Bend, date not known; Navigator, 1817, does not mention the lake.)

11. From Horseshoe Lake, following the belt of swamp in the right bank of Old Town Bend, and against the high land behind Island 62, around the next three bends, showing Island 63 larger than now, the chute of 64 in a considerable width (Navigator, 1817, gives 64 in middle of river), and an island opposite 64 in about the position of Robsons tow-head, Jacksons Point apparently extending to Island 65, and Island 66, or a narrower island, cut off through the depression across its middle.

12. Following around Island 67, with its chute open, the river had to Concordia Bend a straighter course than now. Ross's lines are not very characteristic; Pitman's show, on the right bank, the line of high ground occupied by the levee to a little below Laconia; thence following the chute of Island No. 70 into Scrub Grass Island, with a small island cut out, whose chute is indicated on the detail charts, by a belt of swamp, and on the left bank, very nearly the lines of levee, with a narrow island representing the lowlands of Hurricane Point; thence through Scrub Grass and Victoria bends, leaving Smiths Point broader than now, and the small island at its end smaller. (Pitman shows three breaks in the right bank, which agree in position with the double mouth of White River and One Mile Bayou, but does not give the name of White River. Ross gives the name of White River to what, I think, is the Deep Bayou. He draws the junction of the White and Arkansas, but much north of its true position. It appears to me that he must have drawn the rivers from description, not from observation, and mistaken the White, as above. Collot gives the two names, and the rivers, and their junction fairly well.)

Crevasse measurements.

[For notes on reduction, see p. 3678.]

MISSISSIPPI RIVER, THIRD DISTRICT.

Name.	Distance from Cairo.	Bank.	Width.	Discharge per second.	Date of break.	Date of observation.	Method.
	Miles.		*Feet.*	*Cubic feet.*	1892.	1892.	
Fulton Lake	439	Right.	1,666	*14,988	June 2	June 8	Meter No. 5.
Do	439	Right.	1,809	15,960	.....	June 18	Do.
Do	439	Right.	1,922	19,554	.....	June 22	Do.
Panther Forest	452	Right.	1,091	74,214	May 13	May 17	Meter No. 39.
Do	452	Right.	1,410	69,550	.....	May 25	Do.
Do	452	Right.	1,673	80,884	.....	June 2	Meter No. 38.
Do	452	Right.	2,085	91,623	.....	June 17	Do.
Columbia	470	Right.	398	†18,483	June 22	June 25	Meter No. 39.
Leland	484	Right.	312	9,800	May 25	June 1	Surface floats.
Do	484	Right.	423	17,253	.....	June 16	Do.
Do	484	Right.	423	§6,935	.....	June 25	Meter No. 39.
Brooks Mill	506	Right.	668	‡35,000	May 9	May 13	Surface floats.
Do	506	Right.	715	87,331	.....	June 9	Meter No. 39.
Do	506	Right.	715	80,093	.....	June 24	Do.

*Integration method.
†Meter at six-tenths depth.
‡Results of reduction at office of Third District Engineer.
§Meter 4 feet below surface.

Crevasse measurements.

[Results of reduction at office of Fourth District Engineer.]

MISSISSIPPI RIVER, FOURTH DISTRICT.

Name.	Distance below Cairo.	Bank.	Maximum width of crevasse.	Approximate maximum discharge per second.	Date of occurrence.	Date of closure.	Cause of crevasse.
	Miles.		*Feet.*	*Cubic feet.*	1892.	1892.	
Ascension	882.5	Right.	148	17,200	June 6	June 9	Crayfish holes.
Hermitage	886.5	Left.	63	9,500	June 21	June 23	Do.
New Hope	897	Right.	160	18,100	June 1	June 6	Do.
Delogny	906.5	Right.	126	16,400	June 23	June 28	Do.
Belmont	908	Left.	1,427	139,846	June 12	.....	Do.
Tessier	909.75	Left.	204	25,520	May 22	May 29	Do.
Anchor	929.6	Left.	396	21,000	May 6	.....	Unknown.
Sarpy	937	Left.	1,380	115,920	June 13	.....	Crayfish hole.
Avondale	952	Right.	139	16,120	June 13	June 19	Do.
Villere, No. 1	972	Left.	15	742	May 3	May 4	Do.
Villere, No. 2	971.9	Left.	124	1,816	June 11	.....	Do.
Story, No. 1	975	Left.	23	952	May 28	May 30	Do.
Story, No. 2	974.75	Left.	114	16,560	June 11	.....	Do.
Merritt	976.5	Left.	96	13,500	June 13	June 19	Do.
Belle Chasse	982.5	Right.	107	14,186	June 3	June 15	Do.
Cedar Grove	989.5	Right.	26	686	May 24	May 28	Old rice flume.
Belair	995	Left.	62	8,700	May 24	May 28	Crayfish hole.
Monsecour, No. 1	998.9	Left.	24	2,100	May 11	May 11	Do.
Monsecour, No. 2	999	Left.	26	2,280	May 29	June 4	Do.
Happy Point	993	Left.	51	6,750	May 18	May 28	Rice flume.
Monsecour, No. 3	999.1	Left.	37	2,785	June 7	June 18	Crayfish hole.
Harlem*	1,002.0 to 1,003.2	Left.	441	22,050	May 12 to June 10	May 15 to July 1	Muskrat, crayfish, and rice flume.
Miller	1,011.7	Left.	39	5,985	.....	June 14	Muskrat.
Octave	1,012.0	Left.	35	5,000	.....	May 14	Do.
Martin	1,013.5	Left.	194	3,492	.....	July 2	Caving bank.

*In a distance of 6,000 feet there were 11 breaks at Harlem, and figures presented are aggregates.

BAYOU LAFOURCHE.

Hill	.....	.....	145	.....	May 9	.....	
Upper Ten	.....	.....	40	.....	July 2	July 3	
Boudreaux	.....	.....	225	.....	Apr. 25	.....	

ATCHAFALAYA RIVER.

Philip White	.....	.....	6,000†	.....	June 16	.....	

†About.

APPENDIX 3 K.

OF EARLY MAPS OF MISSISSIPPI RIVER. BY CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

ST. LOUIS, MO., *June 9, 1893.*

ERAL: I have the honor to present the result of a study of some early maps of ississippi River, as compared with those of the Commission.

three maps herewith shown are:

"Course of the River Mississippi, from the Balise to Fort Chartres. Taken expedition to the Illinois in the latter end of the year 1765. By Lieut. Ross, Thirty-fourth Regiment. Improved from the surveys of the river made by rench."

"A draft of the Mississippi River from the Balise up to Fort Chartres," from a to the secretary of state for the colonies, by Capt. Philip Pitman, published ndon in 1770.

"Map of the course of the Mississippi from the Missouri and the country of linois to the mouth of the river," from the travels of Gen. Victor Collot, pub- in Paris in 1826.

Ross, directly, I have been able to learn nothing. Fort Chartres was turned y its French commandant to the English commission on November 11, 1765. the privilege of tracing the map I am indebted to the Missouri Historical y.

nan, for the reading of whose report and the privilege of tracing the map I debted to Col. George E. Leighton, of St. Louis, describes himself as having mployed in "those countries" for five years as an engineer. The only date oned in his report is 1768.

ot, a young officer of the etat-major under Rochambeau in America, briga- eneral and governor of Guadaloupe under the Republic, prisoner of war and Philadelphia by the English in the winter of 1795–'96, was detained in this y by a lawsuit, and was, at his own suggestion, commissioned by Citizen Adet lore the former French province of Louisiana. His book, in the hands of the r at the time of his death, but not published till long after, shows great intel- e, acute observation, and a scrupulous accuracy in stating what he saw him- nd what he reports from hearsay. He left St. Louis on September 16, 1796, in n boat (pirogue) with one white assistant and four Indians, and reached three s above New Orleans, when he was arrested as a spy by Baron Carondelet, on er 26.

he three, Pitman has the largest scale and the fullest detail, and is most con- nt for comparison. Ross is very noteworthy for the accuracy of his topo- ical eye and his rendering of characteristic outlines. Collot has the best l alignment. I regard them all as topographical reconnoissances, probably d by compass bearings and estimated distances, and from the general goodness ir latitudes, probably checked by altitudes of Polaris. The later forms of abe or the single reflecting sextant would have made this practicable. It is t needless to state that the longitudes are all bad.

comparison of the three, I have selected a series of clearly recognizable points a meander line of the general course of the river, platted them directly from 's map, which is on smaller scale, and constructed the others by offsets from raight line, Cairo–New Orleans. The results are shown on the accompany- at.

the course of the river, I have collated the old maps with the "Alluvial Val- ooking for details to the inch-mile series, and occasionally even to the contour of the detail charts. By the topography surveyed about 1880, I find, from to Donaldsonville, the river bed of 1765 recognizable in the present bed, the f lakes, the lines of bayous, sloughs, and creeks, the belts of swamp, the depres- as shown by the contour lines, and the lines of levee following old banks se of their altitude. In making this comparison I have derived some little m the reconnoissance of 1821 by Young, Poussin, and Tuttle, and much more the "Navigator," edition of 1817, a pilot's guide describing the channels by nce to points and islands.

egards the shortening of the bed by cut-offs, it is noticeable that, from 1765 to there is no change of this character. Since 1800 there has been no such period rty-one years. Four cut-offs, whose dates are undetermined, occurred between nd 1817—the Montezuma Bend, Grand Lake, Yazoo, and Homochitta. The igator" mentions the old beds at Grand Lake and the Yazoo Bend as filled, and rown, but recognizable by the smaller willows therein. The others are not ed to. Humphreys and Abbot, in their summary of tradition of early floods,

signalize that of 1799. From the filling and growth I surmise that these cut-offs are of date at least as early.

As regards the lengthening of the bed by erosion of concave banks and building out of points in the bends, this more gradual and widely distributed change is noticeable, even on these small-scale maps, in most of the greater bends. There are points where bends have been shortened; most of these are in the neighborhood of cut-offs, but there remain Plum Point, the "Devils Elbow," Grand Gulf, and Port Hudson. The most interesting instance of the lengthening of a bend is at Cowpen Point. The bend around Vidal Island is apparently a very old bed. Concordia Lake, east of the island, suggests a cut-off at the neck of the old bend and a subsequent lengthening of the point. In 1765 the river bent around a broad, obtuse point having not half the length of Cowpen; now the river has moved three-quarters of the distance from the last-named channel towards Concordia Lake.

The characteristic movement downstream of both points and islands, by erosion of the upstream bank and building out of the downstream one, while preserving the same general outline, is observable in many of the larger points. The change of direction of the axis of the point, shown in a few instances by the caving-bank survey of 1891–'92, I find only in Coles Point and doubtfully in one or two others.

As regards the breadth of the river, I do not think that any trustworthy conclusions are to be drawn from these maps. Ross and Collot probably drew from one sight of the river only. Their delineations of width show characteristic proportions, but I do not look to them for measurements. Pitman undoubtedly knew the river much better than either of them. The great width of the river on his map is very noticeable. In studying his work, I find his bank line often agreeing well with the higher land, and a dotted line suggesting a submerged bar, agreeing fairly with the lowlands, while islands are shown which, with a relief at all like the present, would not be visible at a stage such as to fill his banks. I conclude that he drew the lines of the most permanent and characteristic banks (perhaps, not unreasonably, despairing of determining any other) and drew the islands as he saw them. I do not think that his delineation corresponds to any actual or possible stage, nor that any measurement of width can be taken upon it.

The following is a description of the river bed of 1765–'96 by modern topography and current names. The numbers of paragraphs correspond to the maps of the inch-mile series:

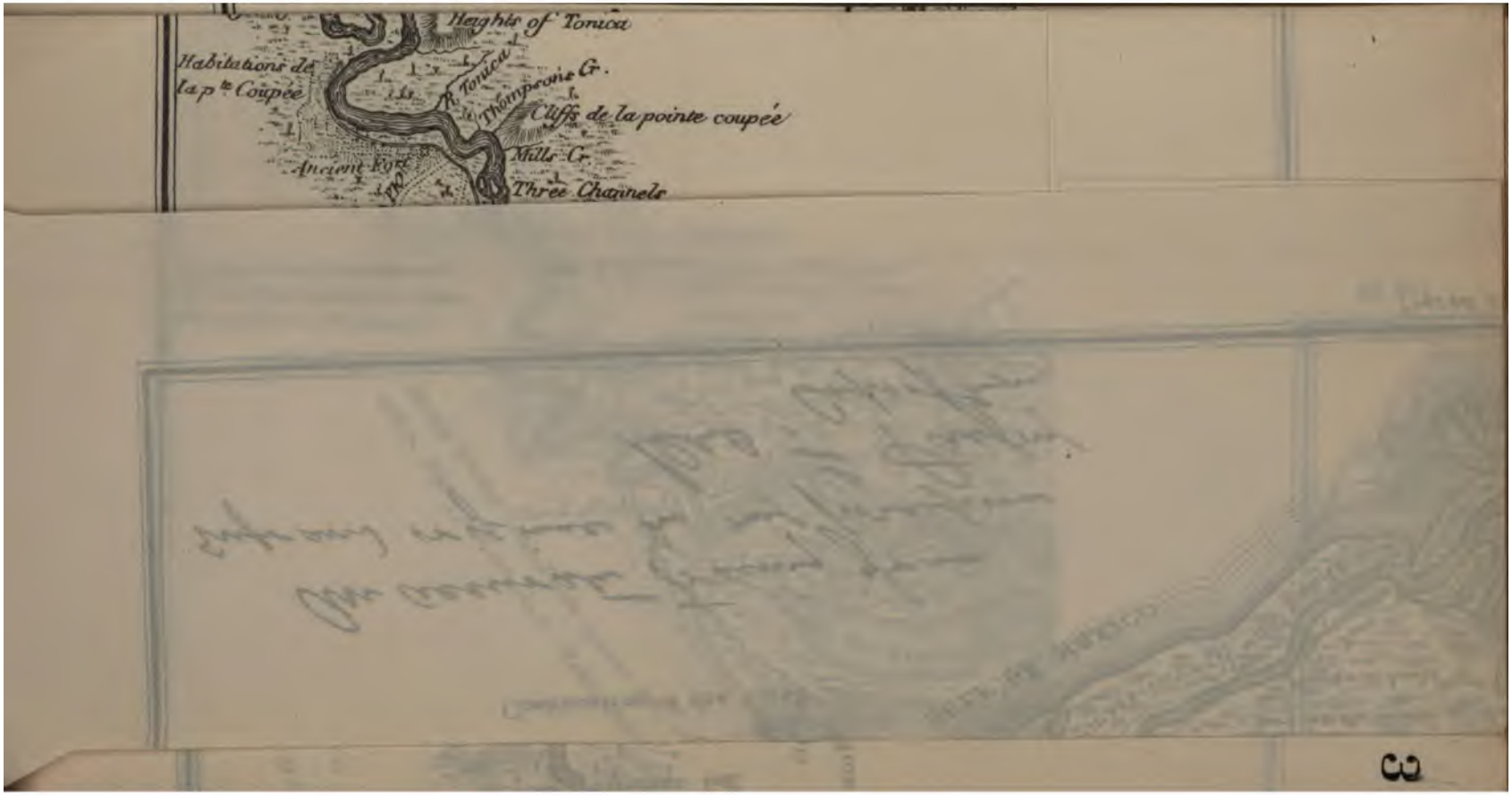
1. From Cairo, bending boldly eastward, probably as far as Lost Pond, then following the line of the creek flowing southward from near Flat Pond, the lower part of Mayfield Creek and the back slough. The turn corresponding to Lucas Bend is not deeper than through the chute of Island No. 2, and Pitman shows the space between that chute and the bluffs as a group of small islands. The point on which Belmont is situate and the bend against the bluffs near Columbus are as now. All show an island corresponding to No. 5, with the chute straighter and broader.

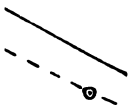
2. Below Columbus the river is closer to the bluffs and near the line of Long Pond and the lower reaches of the Little Obion. French Point and Island No. 8 (to which Ross gives the name of "Wolf") are very recognizable in shape and position.

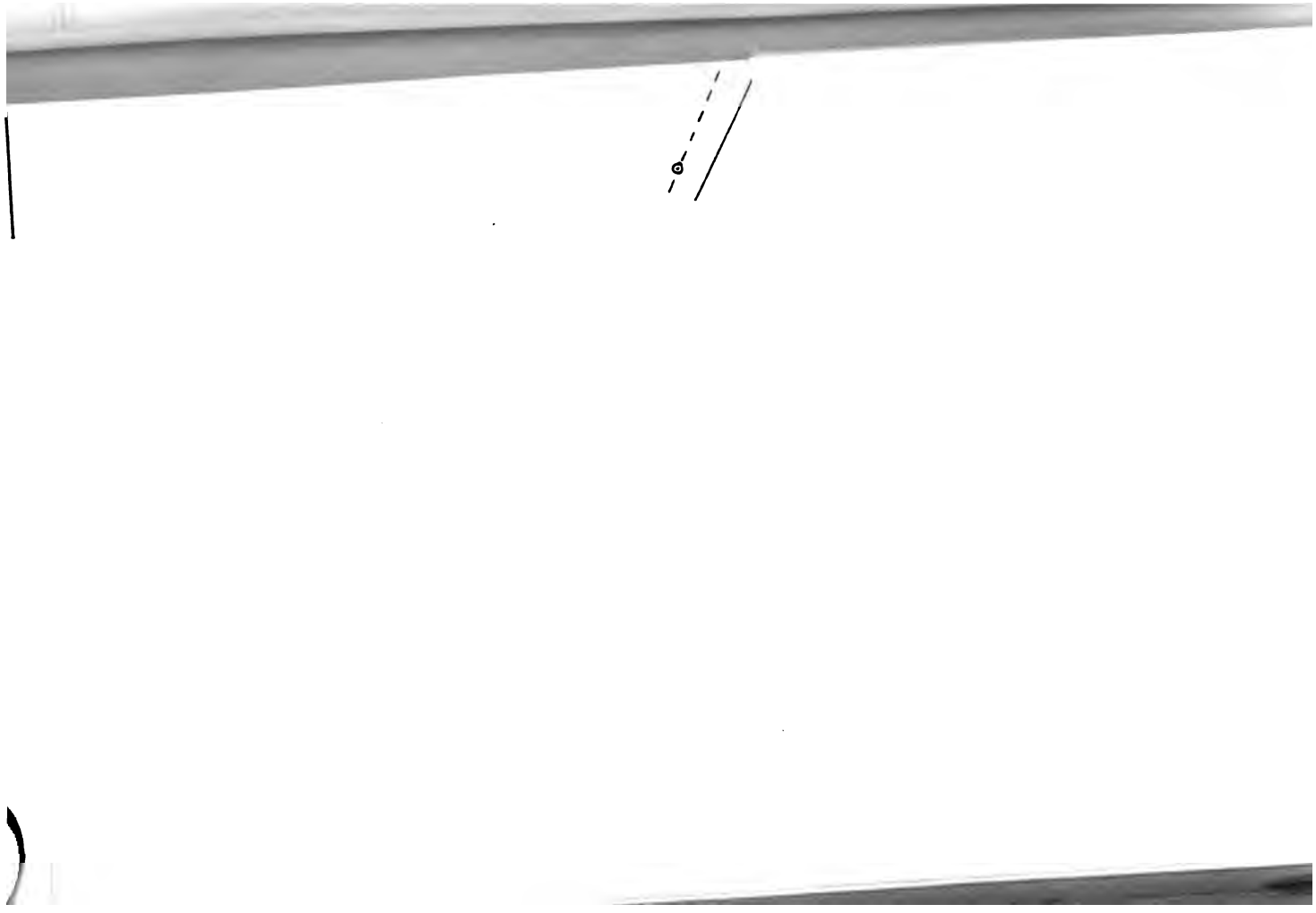
3. Below French Point the river divides around Island No. 9 in about equal channels. Donaldsons Point is shorter than now, ending about with the present cultivated land. All the maps show a long island against the opposite bank in the bend (No. 10?). Watsons Point nearly as now; little shorter, with its extremity broken into islands. Ross notes St. John Bayou as "Chepoussea or Sound River." Pitman shows mouths of two bayous in position of St. John and the Dry Bayou. Below New Madrid the curve to the westward is full, as through the old chute of Island No. 11. Darnells Point is part of a fully rounded curve which continues around the old chute of Island No. 12, which island appears in all. Ruddles Point and Little Cypress Bend are much as now, except that the chute of Island No. 13 is open.

4. In the bend below, Pitman indicates the lower opening of the "old river" shown on our maps, and Ross sketches doubtfully its whole line. The point to which Island No. 14 is now joined is shown with an island longer than No. 14 along its front, but presenting nearly the same general outline. The Little Prairie Bend (which name appears in French and English) is not so sharp as now; the opposite point has nearly the same outline below, but its upstream bank is straighter. Islands 16 and 17 show as a single island as now. No. 18 is very recognizable, its chute much wider. Islands 20 and 21 appear as one island in Pitman, though separate in Ross. The main channel leaves them on the right, curves around the present highest land, into the "old river" around Needhams Island. (The reconnoissance map of Young, Poussin, and Tuttle, gives the date of this cut-off, February, 1821.) Pitman indicates a tributary in the position of the Obion River, but does not note the Forked Deer; Ross has a tributary in the bend above, apparently intended for the Obion.

5. The higher land of Ruckers Point, just back of a narrow belt of swamp, the


Heights of Tonica
Habitations de
la pte Coupée
R. Tonica
Thompsons Cr.
Cliffs de la pointe coupée
Ancient Fort
Mills Cr.
Three Channels





Shipment of bulk grain by river to New Orleans during 1892.

Date.	Name of boat.	Corn.	Wheat.	Oats.	Bulk grain.	Other freight.	Total.
		Bushels.	*Bushels.*	*Bushels.*	*Tons.*	*Tons.*	*Tons.*
n. 4	Sidney Dillon and barges	.....	74,000	.....	2,220	.....	2,220
b. 1	My Choice and barges	.....	65,000	.....	1,950	.....	1,950
1	Sidney Dillon and barges	.....	62,500	.....	1,875	.....	1,875
3	Jay Gould and barges	.....	104,200	.....	3,125	.....	3,125
8	My Choice and barges	.....	83,100	.....	2,195	960	3,155
9	Sidney Dillon and barges	.....	136,800	.....	4,105	.....	4,105
12	.....do	.....	134,500	.....	4,035	.....	4,035
16	.....do	14,000	82,416	.....	2,865	695	3,560
18	Jay Gould and barges	.....	124,660	.....	3,740	.....	3,740
22	.....do	.....	133,253	.....	3,995	.....	3,995
25	.....do	.....	144,244	.....	4,265	.....	4,265
27	Sidney Dillon and barges	.....	100,000	.....	3,000	870	3,870
ar. 1	Jay Gould and barges	.....	146,830	.....	4,285	.....	4,285
3	Sidney Dillon and barges	.....	145,500	.....	4,365	.....	4,365
7	Jay Gould and barges	50,000	77,335	.....	3,720	1,120	4,840
8	Sidney Dillon and barges	64,920	63,250	.....	3,715	.....	3,715
9	E. M. Norton and barges	50,000	99,925	.....	4,395	.....	4,395
12	Jay Gould and barges	145,500	.....	.....	4,365	.....	4,365
12	Sidney Dillon and barges	47,735	47,390	.....	2,757	1,148	3,905
16	Jay Gould and barges	91,445	50,999	.....	4,090	.....	4,090
16	E. M. Norton and barges	43,000	80,270	.....	3,630	.....	3,630
19	Geo. Lysle and barges	.....	87,321	.....	2,619	1,136	3,755
19	Sidney Dillon and barges	48,017	88,673	.....	4,005	.....	4,005
19	Jay Gould and barges	89,765	46,030	.....	3,895	.....	3,895
23	Geo. Lysle and barges	85,696	39,456	.....	3,480	.....	3,480
25	Jay Gould and barges	100,500	45,347	.....	4,175	.....	4,175
28	My Choice and barges	50,550	47,000	.....	2,825	.....	2,825
28	Jay Gould and barges	89,854	36,869	.....	3,620	.....	3,620
28	Sidney Dillon and barges	46,000	96,418	.....	4,180	.....	4,180
30	E. M. Norton and barges	105,640	.....	.....	2,960	1,050	4,010
pr. 1	Sidney Dillon and barges	104,000	41,066	.....	4,145	.....	4,145
4	Jay Gould and barges	93,300	51,000	.....	4,140	.....	4,140
9	L. Houck and barges	.....	136,733	.....	4,100	925	5,025
11	Jay Gould and barges	140,240	.....	.....	3,925	.....	3,925
13	H. Lourey and barges	145,979	44,599	.....	5,425	.....	5,425
13	Sidney Dillon and barges	55,406	.....	.....	1,550	.....	1,550
15	Jay Gould and barges	49,373	101,938	.....	4,440	.....	4,440
15	E. M. Norton and barges	95,000	.....	.....	2,620	.....	2,620
16	Sidney Dillon and barges	153,143	.....	.....	4,285	.....	4,285
18	E. M. Norton and barges	.....	77,522	.....	2,325	.....	2,325
19	Jay Gould and barges	97,020	.....	.....	2,715	.....	2,715
22	My Choice and barges	109,033	.....	.....	3,053	1,027	4,080
22	Sidney Dillon and barges	43,449	33,951	.....	2,235	.....	2,235
27	Future City and barges	107,000	50,783	.....	4,520	.....	4,520
27	Sidney Dillon and barges	74,858	24,855	.....	2,840	1,000	3,840
ay 4	Jno. Gilmore and barges	152,049	.....	.....	4,257	1,188	5,445
10	Henry Lourey and barges	95,760	.....	.....	2,680	1,270	3,950
10	Sidney Dillon and barges	149,561	.....	.....	4,190	.....	4,190
19	H. M. Hoxie and barges	.....	.....	.....	.....	1,875	1,875
ne 2	S. H. H. Clark and barges	.....	.....	.....	.....	1,415	1,415
13	Future City and barges	21,116	.....	.....	590	830	1,420
23	My Choice and barges	.....	.....	.....	.....	1,010	1,010
ly 2	Jno. Gilmore and barges	.....	46,003	.....	1,360	1,360	2,720
11	Henry Lourey and barges	94,400	44,794	.....	5,510	1,960	7,470
16	H. M. Hoxie and barges	.....	80,014	.....	2,400	1,150	3,550
23	S. H. H. Clark and barges	.....	30,000	.....	900	1,425	2,325
30	Oakland and barges	.....	135,391	.....	4,062	1,443	5,505
ug. 4	My Choice and barges	.....	118,535	.....	3,555	.....	3,555
8	Jno. Gilmore and barges	.....	68,965	.....	2,070	1,135	3,205
9	Sidney Dillon and barges	.....	105,000	.....	3,150	.....	3,150
10	H. Lourey and barges	.....	102,550	.....	3,080	.....	3,080
12	E. M. Norton and barges	41,523	61,760	.....	3,025	.....	3,025
12	H. M. Hoxie and barges	37,931	69,000	.....	3,130	.....	3,130
13	Sidney Dillon and barges	.....	106,495	.....	3,195	.....	3,195
13	S. H. H. Clark and barges	.....	35,000	.....	1,050	1,455	2,505
20	My Choice and barges	.....	100,094	.....	3,000	.....	3,000
20	Jay Gould and barges	.....	33,365	.....	1,000	590	1,590
26	Sidney Dillon and barges	.....	70,618	.....	2,120	.....	2,120
28	My Choice and barges	.....	53,466	.....	1,602	438	2,040
29	Jay Gould and barges	.....	67,176	.....	2,015	.....	2,015
pt. 3	Sidney Dillon and barges	.....	66,439	36,857	2,582	793	3,375
3	My Choice and barges	.....					
10	Sidney Dillon and barges	.....	39,465	.....	1,180	585	1,765
10	My Choice and barges	.....	60,535	.....	1,815	.....	1,815
14	.....do	.....	62,375	.....	1,870	.....	1,870
17	Sidney Dillon and barges	.....	44,831	.....	1,342	873	2,215
22	My Choice and barges	.....	60,791	.....	1,825	.....	1,825
25	Sidney Dillon and barges	.....	.....	.....	.....	1,660	1,660
30	My Choice and barges	.....	65,390	.....	1,960	.....	1,960
t. 1	Sidney Dillon and barges	.....	19,160	.....	575	1,110	1,685
5	My Choice and barges	59,487	.....	.....	1,665	.....	1,665
8	Sidney Dillon and barges	20,103	.....	.....	564	1,216	1,780

Shipment of bulk grain by river to New Orleans during 1892—Continued.

Date.	Name of boat.	Corn.	Wheat.	Oats.	Bulk grain.	Other freight.	Total.
		Bushels.	*Bushels.*	*Bushels.*	*Tons.*	*Tons.*	*Tons.*
Oct. 12	My Choice and barges		35,166		1,055		1,055
15	do		34,070		1,020		1,020
17	Sidney Dillon and barges					1,270	1,270
25	My Choice and barges	18,700			523	1,462	1,985
26	Sidney Dillon and barges	30,215	33,918		1,800		1,800
31	My Choice and barges	16,800			470	875	1,345
Nov. 3	Sidney Dillon and barges	20,802	20,776		1,385		1,385
5	My Choice and barges	16,083	14,500		885		885
8	Sidney Dillon and barges					870	870
13	My Choice and barges		15,112		425		425
16	Sidney Dillon and barges		42,700		1,280		1,280
19	My Choice and barges		43,650		1,310		1,310
24	Sidney Dillon and barges		17,200		518	1,542	2,060
24	My Choice and barges		43,200		1,300		1,300
28	Sidney Dillon and barges		30,500		915		915
29	My Choice and barges		42,615		1,280		1,280
Dec. 5	Sidney Dillon and barges		15,500		465	1,300	1,765
10	My Choice and barges	28,486			800	270	1,070
12	Sidney Dillon and barges	35,206	13,876		1,400		1,400
	Total	3,228,645	5,149,708	36,857	246,979	42,301	289,280
Via Belmont and Cairo:							
January		886,430	669,221		44,900		44,900
February		1,110,620	169,022		36,170		36,170
March		422,900	51,084		16,440		16,440
April			64,000		1,420		1,420
July			45,000		1,350		1,350
August			81,000		2,430		2,430
September			19,000		520		520
December		114,592	414,764		15,650		15,650
Grand total		5,763,187	6,662,799	36,857	365,859	42,301	408,160

Shipments by New Orleans boats and barges for three years.

Articles.	1892.	1891.	1890.
Apples, barrels	164	144	348
Ale and beer, packages	2,570	1,892	2,503
Bagging, pieces	16,226	22,973	38,276
Barley, sacks	41	4	39
Barley, bushels			
Barbed wire, pounds	20,260	253,864	1,831,163
Butter, do	2,028	1,105	9,377
Bran, sacks	34,674	46,507	70,746
Cattle, head	8	1	5
Corn, sacks	58,930	96,084	152,903
Corn in bulk, bushels	3,228,645	1,482,731	8,717,850
Corn meal, barrels	77,622	80,905	133,997
Cotton, bales			2,054
Cotton-seed meal, tons			
Eggs, packages			2
Flour, barrels	262,944	222,329	330,300
Hay, tons	409	754	956
Horses and mules, head	244	243	704
Hogs, do	5	23	24
Hominy and grits, barrels	20,410	23,978	40,247
Pork, do	3,497	5,896	6,279
Hams, pounds	81,076	85,194	131,928
Meats, do	1,325,714	1,143,318	1,789,865
Lard, do	7,450,298	6,869,200	8,116,580
Malt, sacks			15,845
Oats, do	95,649	257,728	403,173
Oats in bulk, bushels	36,857		89,960
Onions, packages	86	270	153
Potatoes, do	463	245	656
Rye, sacks	120	42	1,036
Rye in bulk, bushels		45,600	
Sheep, head			
Tallow, pounds	359,194		220
Tobacco, hogsheads			
Tobacco, manufactured, pounds	15,794	7,473	36,757
Wheat, sacks	51	207	418
Wheat in bulk, bushels	5,149,708	6,940,215	1,409,440
Whisky, barrels	443	402	1,048
White lead, pounds	1,124,415	1,050,481	1,184,295
Merchandise and sundries, packages	153,979	87,877	189,651
Total, tons	315,605	331,850	418,400

Shipments by Memphis, Vicksburg, and Natchez boats for three years.

Articles.		1892.	1891.	1890.
	barrels	1,174	1,112	2,026
d beer	packages	35,423	34,003	33,127
g	pieces	13,972	56,233	40,349
	sacks	59	234	577
	bushels			
l wire	pounds	1,090,958	2,034,106	879,045
	do	34,268	31,540	94,761
	sacks	8,429	26,393	39,533
	head	52	34	77
	sacks	80,324	144,563	119,403
in bulk	bushels			
eal	barrels	117,909	157,012	201,964
	bales	5		
-seed meal	tons			
	packages	60	56	270
	barrels	61,205	131,358	173,970
	tons	1,715	2,675	3,488
and mules	head	1,577	1,545	1,834
	do	42	82	181
y and grits	barrels	3,324	3,466	4,778
	do	6,301	5,738	7,507
	pounds	222,152	491,238	791,112
	do	6,566,373	11,089,187	13,066,078
	do	985,443	1,284,463	1,338,629
	sacks		50	362
	do	63,012	116,009	123,234
n bulk	bushels			
	packages	3,170	3,357	2,246
es	do	14,188	12,359	13,365
	sacks	260	381	1,378
n bulk	bushels			
	head	2	160	6
	pounds			
o	hogsheads	38	2	
o, manufactured	pounds	247,500	242,185	489,363
	sacks	938	370	173
, in bulk	bushels			
y	barrels	2,319	3,023	2,909
lead	pounds	458,611	495,717	536,637
andise and sundries	packages	747,855	872,774	1,091,650
Total	tons	77,065	112,420	125,405

fied statement for three years of commodities transported to St. Louis from the Lower Mississippi by the St. Louis and Mississippi Valley Transportation Company.

Commodities.		1890.	1891.	1892.
, machinery, etc	packages	2,116	2,251	1,603
t	barrels	169,415	182,084	129,950
cals, caustic, etc	packages	2,057	1,585	3,273
rn and glassware	do	5,703	10,577	1,230
ser	do		7,533	2,408
ars, rails, etc	do	14,706	2,105	
ig and scrap	tons	204		
o	packages	12,255		
r	feet	1,252,980	988,051	325,977
d paints	barrels	210	52	598
	packages	13,204	9,500	17,262
	do	6,672	6,989	11,499
es	bundles	78,710	163,447	166,601
bars, blooms, etc	tons	1,121	6,137	1,024
ste	boxes		576	925
es	packages	4,137	2,370	2,621
Total	tons	47,282	52,291	40,425

HENRY P. WYMAN,
Secretary.

LOUIS, *June 5, 1893.*

STATEMENT OF THE PITTSBURG COAL EXCHANGE.

PITTSBURG, *June 7, 1893.*

SIR: The following list shows the coal shipments for the year 1892 to the various points on the Mississippi River. These statistics were not available when your letter was received, but had to be collected from the different operators:

	Bushels.
1. Points on the Mississippi down to and including Memphis	6,450,000
2. Points below Memphis down to and including White River	1,500,000
3. Points below White River down to and including Vicksburg	3,550,000
4. Points below Vicksburg down to and including New Orleans	34,750,000
Total	46,250,000

Number of steamers employed, 17; their total tonnage, 9,000.
Return freight, empty craft, if any.

Very respectfully,

THE PITTSBURG COAL EXCHANGE,
J. FRANK TILLEY, *Secretary.*

Capt. CARL F. PALFREY,
Corps of Engineers.

STATEMENT SHOWING RECEIPTS AT CINCINNATI FROM POINTS ON MISSISSIPPI RIVER, YEAR ENDED DECEMBER 31, 1892.

From all points, New Orleans to Memphis.

Cement	barrels	800	
Scrap iron	tons	95	
Lumber	feet	427,000	
Merchandise	tons	1,140	
Molasses	barrels	18,480	
C. S. oil	do	671	
Rice	do	7,734	
Sugar	do	5,774	
Sugar	hogsheads	129	
Shingles	bundles	28,368	
Cotton	bales	6,911	
Moss	bales	990	
Paper stock	bales	924	
Aggregate tonnage			11,393

From all points, Memphis to Cairo.

C. S. meal	bags	45,960	
Cotton	bales	32,632	
Scrap iron	tons	100	
Merchandise	tons	401	
C. S. oil	barrels	1,000	
Soap stock	do	2,088	
Spar	do	6,351	
Lumber	feet	1,787,000	
Aggregate tonnage			16,418
Total tonnage			27,811

STATEMENT SHOWING SHIPMENTS FROM CINCINNATI TO POINTS ON MISSISSIPPI RIVER, YEAR ENDED DECEMBER 31, 1892.

To all points south of Memphis to New Orleans.

Nails	kegs	44,571	
Iron	tons	1,126	
Merchandise	tons	8,954	
Aggregate tonnage			11,393

All points south of Cairo to Memphis.

Nails	kegs..	111,328	
Salt	barrels..	16,025	
Iron	tons..	1,547	
Merchandise	do....	6,364	
Aggregate tonnage			16,678
Total tonnage			28,071

APPENDIX 4.

REPORT OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1893.

GENERAL: I have the honor to submit the following report of operations in the First and Second Districts for the period May 31, 1892, to May 31, 1893:

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky. (21 miles below Cairo).—The work of improvement at this point consists of five spur dikes built in 1889–'90 to protect about 2,200 feet of bank in front of the town which was threatening to cave. No injury to the spurs has been noted since their completion in October of 1890, and no further work is at present required.

Hickman, Ky. (36 miles below Cairo).—The acts of 1886 and 1888 contained specific appropriations for this locality amounting together to $88,750. The evil to be remedied was the caving of the bank in front of the town. Owing to the existence of a projecting point of tough clay above the town, it was possible to do this with a small development of work. A continuous revetment about 1,000 feet long, extending downstream from the clay point, was placed in October, 1890, its downstream end resting on a second clay point opposite the middle of the town. After the flood of 1891, a slight undermining of the downstream end of the mat above water was noted, which was further enlarged by the flood of 1892. The injury was limited to the portion of the mat above low water, and was repaired in October and November, 1892, by extending the shore mattress downstream to cover the pocket which had been scoured out below the end mat. The balance of the mat above low water remained uninjured, but had become much weakened by decay of the brush of which the mattress was constructed. To strengthen it, a layer of riprap stone 10 inches thick was placed along the whole revetment, extending from low water up to the level of the 7-foot stage. The ballast will be extended further up the bank, if necessary, the coming season.

A survey of the whole harbor front at this point was made in October of 1892, and included sections 100 feet apart over the existing revetment. Very great depths were found. At the downstream end of the mattress the depth was 97 feet below low water at a point 200 feet from the bank. One hundred feet further upstream the depth was 116 feet at a point 225 feet from the bank, and the same depth was found in the section next above it, and at about the same distance from the shore. The existence of these greath depths so near the shore are a great menace to the permanence of the revetment, but there is nothing to show that any portion of the river mat has yet been lost. No further work is recommended at this locality at the present time beyond placing such additional stone ballast on the shore mats as may be found necessary after the water recedes.

New Madrid, Mo. (71 miles below Cairo).—To comply with the requirements of the act of September 19, 1890, as interpreted by the Secretary of War, the Commission allotted $1,000 from the appropriation contained in that act to be expended in making a survey. The survey was made in September and October, 1891. The evil which the inhabitants desire to have corrected is the caving of the bank in front of the town. Between 1880 and 1884, the bank caved away at an average rate of 113 feet a year, and between 1884 and 1891 at the rate of 57 feet a year. It was estimated that $70,000 would be required to protect the bank immediately in front of the town. The river and harbor act of July 13, 1892, contained a specific appropriation of

$25,000 for the improvement of this locality. By resolution of the Commission, as approved by the Secretary of War, this sum is to be expended in revetting the bank opposite the upstream portion of the town, beginning at the upper limit of the town at Dry Slough and extending downstream as far as the funds will allow. The stone required has been stored on the bank during the present high water, and it is contemplated to build the revetment the first thing this season, beginning probably the latter part of June.

Plum Point Reach (147–186 miles below Cairo).—Under this title works of improvement have been executed at various points between Daniels Point and Craighead Point, a distance by river of about 20 miles. They are fully described in previous report. During the current fiscal year the improvement of the reach has been continued by the construction of new revetment in Ashport Bend, and by repairs to the revetment at Daniels Point and Fletchers Bend.

Ashport Bend.—The shape and position of the bank line in this bend exert a controlling influence on the effectiveness of the works of improvement lower down in the reach, and its protection against caving formed a part of the original project for the improvement of this reach. Revetment was commenced in 1882, at the upper end of the bend, but was suspended after 2,694 linear feet had been built, in order that the plant and funds designed for this point might become available for other works which had developed into greater urgency in the course of the same season. No steps were taken to resume the work till 1890. In that year an allotment was made to begin the revetment, and in the following year a second allotment of sufficient amount was made to complete the protection of the entire bend. Work was commenced late in the fall of 1891, and 3,250 linear feet of revetment was placed before the end of the season, beginning at the upper end of the bend. During the following high water as much as possible of the riprap stone required to complete the work was purchased and stored on the bank. The revetment work was resumed early in August of 1892, and actively prosecuted until the close of the season in February, 1893. Two mattress ways had been provided, and with these it was hoped to complete the revetment of the entire bend before the end of the season, but the withdrawal of one of the ways for the repairs at Daniels Point in October made this impossible. Good progress was, however, made with the one plant, and 8,504 feet of revetment completed before the end of the season, leaving about 4,000 feet of bank at the lower end of the bend yet to be protected.

Grading.—The most difficult feature of the work was the preparation of the bank for paving above low water. For a distance of over 1,000 feet in the vicinity of Mud Point the composition of the bank was of a treacherous nature, causing the bank to cave or slough off in large blocks, giving the bank line a very irregular shape of salients and reëntérings. But little grading was possible here, and but little was done. There was, however, along the greater portion of this bank a natural slope of about 1 on 2½ to 1 on 3 from the low-water line up to the level of the 15-foot contour, on which the shore protection could be placed without grading. Below this point the bank line was uniform in shape and direction and favorable for grading. The grading was, however, slow and tedious on account of the large number of old cypress stumps encountered at all points of the graded slope, being the relic of an old cypress swamp, which the surface deposit of the present bank entirely covers and conceals. At one point there were 74 stumps in the graded slope along 300 feet length of bank, and this was by no means the most thickly wooded portion. Grading opposite two of the mats was done before the mats were sunk, but with very unsatisfactory results, as the bank sloughed badly at the water line. Resort to hand dressing, at considerable expense, was had to establish a suitable slope for the riprap paving. After this the grading was done after the river mats were sunk, and with much more satisfactory results, there being but little caving or sloughing after the pockets under the shore edge of the mats had been filled up by the material which was washed down from the bank by the hydraulic jet. The grading was done with large graders Nos. 2 and 4. One month was lost with grader No. 4 on account of a bursted steam cylinder. The two large pumps were taken off and four pile-driver jet pumps were put on instead, and gave good satisfaction during the remainder of the season. To expedite this work, both graders were worked at night between September 28 and October 26, by the aid of a Wells lamp. In November grader No. 4 was transferred to Daniels Point.

River mats.—Construction was commenced with river mats of the width heretofore used, viz, 200 feet, as one of the mattress ways would not permit the construction of a wider one. After 3,952 feet of mat had been built of this width, a new and larger mat-ways was procured, and the remainder of the mats were constructed with a width of 240 feet.

Late in the season, while work was in progress, I received the resolutions of the Commission directing certain changes in the construction of the mats. The resolutions were: (1) "That under-water mattresses shall be thickened by a layer 3 or 4

inches thick of fine brush to make them less permeable; and (2) that the district officers be authorized to experiment on constructing the outer 50 feet of mattress so as to be more flexible, in order to follow the caving of the bank."

The first resolution doubles the amount of brush required in building a given length of mat, and as the brush supply was already inadequate for the ordinary form of construction, causing delay and loss, it was deemed impracticable to carry out the resolutions to the full extent and at the same time build the amount of mattress that was necessary in order to close the gaps between the mats already placed.

When the second mat party was withdrawn from this work for Daniels Point, there existed a long gap between the revetment placed by it and that of the first party, which had to be closed before the end of the season or have an unprotected interval which would be liable to cave back during the succeeding high water and destroy the free ends of the mattress. It being deemed unsafe to leave such an unprotected interval at this point, and it being impossible to close it if the resolution was fully carried out, it was complied with only to the extent of placing an extra layer of brush on the inshore edge of the mat for a width of 40 to 50 feet. Special care, however, was taken here and at other points, to weave the brush more closely than had been the custom heretofore, to connect the top and bottom grillage more securely, and to strengthen the mat lengthwise and crosswise by a more liberal use of steel-wire strand. The mats are believed to be better in every particular than any heretofore built of the same type of construction in the First and Second Districts.

The following are the river mats built during the season:

Mat No. 1.—1,090 feet long, 200 feet wide.

Mat No. 2.—1,038 feet long, the upper 695 feet being 200 feet wide, the remainder 240 feet wide.

Mat No. 3.—Length 1,045 feet, width 200 feet.

Mat No. 4.—Length 989 feet, width 240 feet.

Mat No. 5.—Length 1,122 feet, width 200 feet.

Mat No. 6.—Length 1,103 feet, width 240 feet.

Mat No. 7.—Length 421 feet, width 240 feet. This mat covers the softest part of Mud Point, and has an extra layer of brush over the whole width of mat for a distance of 300 feet.

Mat No. 8*a*.—Length 830 feet, width 240 feet.

Mat No. 8*b*.—Length 866 feet, width 240 feet.

The above is the order in which the mats were built. Geographically they are differently located. The mat farthest downstream is No. 5, and the one next above it No. 8*b*. The latter was built under difficulties, on account of cold weather and ice, and it was found necessary to sink it, on account of ice, before it had been given the length necessary to overlap the head of mat No. 7, thus leaving a short unprotected interval between them.

Connecting mats.—Of these 31 were made, in lengths of from 75 to 400 feet, and widths of 40 to 120 feet. They overlap the river mats about 25 feet, and extended up the bank to the level at which the water line stood at the time they were built. They were built of two thin layers of brush at right angles, with top and bottom grillage poles securely wired together.

Paving.—The paving begins at the low-water line and extends up the graded slope, terminating at a level of about the 18-foot stage. It consists of a thin layer of quarry spalls, on which is placed a layer of riprap stone. At first the paving was given a uniform thickness of 10 inches, but was afterwards made with a thickness of 12 inches for a distance of 5 feet, measured vertically up the slope, then gradually reduced to a thickness of 6 inches at the top of slope.

Spur dike.—In order to break the force of the strong eddy which exists under Mud Point, three spur dikes have been commenced, each consisting of two rows of piles perpendicular to the bank. Owing to the rapidly rising river, they were not completed before suspension of work by high water.

Surveys and borings.—Before any revetment was built, the bend was carefully sounded along sections 100 feet apart, the soundings being referred to a permanently established base line on shore. The soundings were repeated after the revetment was built, and a third set over a portion of the mattress was taken, after the water had risen. The latter indicate a decided scour of the river bed along the outer edge of the mattress at the lower end of the work, and an undermining of a portion of it. Being taken at high water in a swift current, the last set of soundings are, however, not very reliable. A resurvey of the bend will be made at next low water, and it is anticipated that it will throw some light on the manner in which the current at high water acts upon a revetted bank. Test borings to ascertain the composition of the bank in the vicinity of Mud Point are in progress.

For further details see report of Assistant Engineer Aug. J. Nolty.

The cost of the work during the season, including all expenses incidental thereto, except office expenses, is as follows:

River mats	per square	$4.27[6]
Connecting mats	do	8.17
Pocket mats	do	5.90
Paving	per square yard	.91[1]
Grading	do	.038
Cost per linear foot of protection		19.22
Amount expended on this work in 1891–'92		60,171.31
Amount expended on this work in 1892–'93		174,546.30
Total		234,717.61

Daniels Point.—As before reported, a continuous revetment, 5,300 feet long, was placed in this vicinity in 1889 to protect the bank at lower end of Canadian Reach, in which rapid caving had developed. The river mats were 200 feet wide, and were made continuous with the shore work, which also consisted of brush mats lightly ballasted with stone. After the flood of 1890 the upper end of the revetment was found to have been undermined by the caving of the unprotected bank above it, and some settling to have taken place in the shore mat at a point 300 feet below the head of the work. The settling had not been sufficient to rupture the brush work, and no repairs were made this season. During the flood of 1891 this settling had developed into a rupture of the mat, causing a deep pocket and leaving but a small length of revetment in place above it. An examination at low water failing to show that any of the original mat was in place, the break was repaired the same season by a mat 200 feet wide and 300 feet long, and shore work. It was intended, during the same season, to extend the revetment upstream 500 feet, but for reasons given in last annual report, this was not done.

After the flood of 1892, five breaks appeared, which, including the mat lost by undermining at the upper end of the work, involved the loss of over one-half of the original revetment. These breaks were as follows, beginning with the one farthest upstream:

	Feet.
Break No. 1, length	750
Break No. 2, length	330
Break No. 3, length	880
Break No. 4, length	560
Break No. 5, length	530

A careful survey at low water, with soundings along sections 100 feet apart, showed that considerable scour had taken place in the bed of the river along the outer or channel edge of the mat. At the upper end of the revetment depths of 100 feet below low water were found less than 200 feet from the shore, and the loss of mat in this vicinity was doubtless due to the scour which has here taken place since the mats were sunk. The scour was much less at the lower end of the revetment and the causes of breaks 4 and 5 are not so evident. These breaks were made the subject of a special report, dated September 21, 1892, and to repair them the commission provided the sum of $60,000 by transfer from the allotment for Gold Dust Dam, the construction of which was deferred until another season.

The preliminary work of repairing the break was commenced October 8 and mat construction October 13. Breaks Nos. 1, 2 and 3, having practically developed into one continuous break, were treated as such and covered by continuous mattress 1,940 feet long and 240 feet wide. Connecting mats were constructed to cover the pockets between the shore edge of the river mats and the water line. Pocket No. 5 was repaired by mattress 613 feet long and 240 feet wide, with connecting mat and shore paving. Authority having been obtained to experiment in the construction of a fascine mat, it was proposed to cover pocket No. 4 with a mat of this construction, After a study of the subject, it was proposed to build it as follows:

The fascines to be made 12 inches in diameter and in lengths of 50 and 100 feet, and tightly compressed and bound every 3 feet. These fascines were to be placed at right angles to the bank and were to form the woof of the mattress, pairs of longitudinal wire strand cables forming the warp. The top and bottom cables of each pair were clamped together every 3 feet by long cable clamps. On top of the mattress so built a grillage of poles was placed and tied down to the fascines by galvanized wire. The construction of the mat was commenced February 2, 1893, and was very slow work, the best progress made on any one day being about one-half that of the ordinary woven mat. After 173 linear feet had been built, the river became filled with heavy ice, crowding the mooring barges and the mats into an oblique

osition with respect to the bank. To prevent total loss, the unfinished mat was arriedly ballasted and sunk the same day.

The experiment with this form of mat has therefore not been, on the whole, a suc-ess, but enough of it was built to demonstrate that it possessed two great advantages ver the old form of mat, viz.: more flexibility and less permeability. The cost per inear foot of mat is of course some greater than that of the old mat, but the experi-ment was not carried far enough to enable me to give even an approximate estimate of its cost if used on a large scale. Further experiments in the construction of this form of mat will be made at New Madrid during the coming working season.

To aid in breaking up the eddy in the pockets formed by the breaks in the old mat, the spur dikes of piles were commenced as the water began to rise, but the river rose too rapidly to permit their completion before suspension of work by high water All work was discontinued March 1. The revetment will be extended up-stream about 1,000 feet during the coming season.

The cost of repairs of the past season was as follows:

River mat	per square	$5.09
Connecting mat	do	7.8112
Grading	per cubic yard	.063
Paving	do	1.995
Total expended		$54,016.52

Fletchers Bend.—A few unimportant faults in the old work were restored during the season and 4,807 square yards of work reballasted and 684 square yards of addi-tional paving laid, at a total cost of $2,632.66. One of the projects for last season was the repair of a fault in the revetment of Section B, near its upstream end, but owing to the necessity of using the plant at other points, this could not be done. A special allotment of $15,000 has been made for repairing this break, to be done the coming season.

Gold Dust Dike.—The funds withdrawn from this work last season and applied in repairing Daniels Point revetment having been restored by a new allotment of $60,000 it is proposed to build the dam, or as much of it as possible, the coming sea-son. The stone required has been stored on the bank in the near vicinity of the dam.

Bullerton Tow-Head.—The revetment along the channel face of Bullerton Tow-Head has been broken up in places during the past year. For some years after its construction it was not exposed to the action of the current, being protected by an outlying sand bar. This bar was scoured away during the flood of 1892, leaving the channel face of the tow-head exposed to a strong current. Being one of the first experiments in mat building in which mats only 100 feet wide were used, which widths have since been found insufficient, it is probable that the entire revetment will require renewal in the near future, and, in anticipation that a part of it will have to be renewed the coming season, an allotment of $100,000 has been made for this purpose.

Condition of the works in the reach.—The most serious injuries sustained by the works in the reach occurred, as above described, at Daniels Point, Bullerton Tow-Head, and Fletcher Bend. There has also been some further enlargement of the unrevetted gaps in the interrupted revetment in Fletcher Bend, but not of suf-ficient extent to require immediate repairs. The undermining of the lower end of the Plum Point revetment has also continued to a small extent. With these excep-tions the works in the reach are believed to be in substantially the condition reported in the last Annual Report.

Results at Plum Point Reach.—The river was at a low stage from September 1 to December 15, with a minimum of 3.9 feet on the Cairo gauge. The least depths recorded in the reach were 7½ feet in Gold Dust and the same depth at Island 30 crossings. All other crossings gave 10 feet or more.

SURVEYS, GAUGES, AND OBSERVATIONS.

Surveys.—A low-water survey of Plum Point Reach was made in September and of Helena Harbor in October. A survey of Nonconnah Rock was made in September.

During the construction period very careful soundings were made over the revet-ment works at Daniels Point, Ashport Bend, and Hopefield Bend, and the same sec-tions were resounded during April, 1893, when the river was at a much higher stage. The results obtained from these surveys are noted in the description of improvement works at the above localities.

A low-water survey was made of Harris Crossing, just below New Madrid, Mo. This is a shoal locality, and at the time of the survey, October, 1892, there was a least channel depth of 7 feet, with the New Madrid gauge reading 5.7 feet.

In compliance with a resolution of Congress I had a survey made of the lower section of Wolf and Loosa Hatchie rivers, Tennessee, using the regular survey party for this purpose.

Levee surveys.—During December, 1892, and January, 1893, surveys were made a levee location along the upper portion of the St. Francis front. The lengt levee surveyed was 30 miles, in two sections. The upper section was 22½ miles l from Point Pleasant, Mo. (80 R), to Gayoso, Mo. (105 R), and the lower section miles long from Barfield, Ark. (142 R), to the upper end of the Plum Point syste levees at Bear Bayou (151 R).

Discharge observations.—A single low-water discharge was taken at Memp Tenn., October 25, 1892, gauge 1.9 feet. The discharge in cubic feet per sec was 116,756.

High-water discharges were taken in February and March, 1893, at Colum Ky., New Madrid, Mo., Fulton, Tenn., and Helena, Ark. The results have l reduced and forwarded to the secretary of the Commission. This flood was of moderate proportions, the highest stage reached being below extreme high wat 5.4 feet at Columbus and 6.3 feet at Helena.

A second flood in May, 1893, was 2 feet below high water at Columbus, and reached the high-water mark at Helena. Parties were sent to all the above disch stations to gauge this flood, and at some points the observations are still in prog As soon as completed the results will be reduced and forwarded to the secretary

Low water of 1892.—The river was at a low stage from September 1 to Decem 15, reaching its lowest the last of October. The least gauge readings were: C 3.9; Belmont, 2.7; Morrisons, 3.4; Cottonwood Point, 0.4; Fulton, 4.7; Memphis, Mhoons, — 2.2; Helena, 1.2; Sunflower, 3.2.

These readings are some greater than for low water of 1891, being 1.5 great Cairo, 1.1 at Morrisons, 2.0 at Fulton, 0.6 at Memphis, and 0.9 at Helena.

Only 26 shoal crossings of under 10 feet depth were reported by pilots, agains reported in 1891. Of these 20 had less than 9 feet, 13 less than 8 feet, and 4 than 7 feet, the shoalest at Harris being left.

Table of depths at shoal-water crossings, 1892, Cairo to White River.

Name of crossing.	Distance below Cairo.	Depth.	Dat
	Miles.	*Feet.*	
Wolf Island	26	7	Oct.
Beckhams	77	8	Sept
Harris	79	6	Oct.
Point Pleasant	80	7	Sept
Below Point Pleasant	81	8	Sept
Darnells	82	8	Sept
Cherokee	88	6½	Sept
Stewarts	89	9	Sept
Gold Dust	157	7½	Oct.
Island No. 30	162	7½	Oct.
Island No. 34	180	8½	Sept
Centennial	203	9	Sept
Island No. 40	212	7	Oct.
Fort Pickering	232	7	Oct.
Armstrongs	241	9	Sept
Reeves	243	6½	Oct.
Scanlans	248	8	Oct.
Cat Island	253	8	Sept
Norfolk	254	6½	Oct.
Peters	271	7½	Nov.
McCullonghs Tow-Head	272	9	Sept
Hardins Point	288	9	Oct.
Montezuma	312	8	Nov.
Friars Point	319	9	Nov.
Henrico	382	7	Sept
Scrub Grass	384	7½	Sept

Lower St. Francis levee district.—This district includes the area which is subject overflow by water escaping over the right bank of the river between Point Pleasa Mo., and the mouth of the St. Francis River. Its length on a north and south l is about 125 miles and by river 218 miles. Its average width on an east and w line is about 25 miles. The area liable to overflow is estimated at 1,932,000 acres which only 217,000 acres, or 11 per cent of the total, is under cultivation. Lo protection to about 41,000 acres of land in the vicinity of Osceola, Ark., is affor by the levee, about 22 miles long, extending from Bear Bayou to Craighead Po and which was built by the United States in 1886-'87, in connection with other wo for improving the channel of the river in Plum Point Reach.

Above and below this levee the water is practically free to escape over the ba into the lowlands of the basin. The remnants of the old State levee, long since ab

lined, which exist here and there along the whole length of the district, form no barrier to and retard but little the general escape of water over the banks.

The overflows of the past few years have been very destructive to the district, especially that of 1892, which, occurring very late in the season, made it impossible to make any crops whatever in many of the deeply-submerged localities. The present overflow promises to be quite as disastrous as that of 1892.

Realizing that a succession of such overflows would not only prevent any further development of the territory, but would lead to the abandonment of much of it that is now occupied, the inhabitants took prompt steps, after the flood of 1892, to organize themselves into a district for the purpose of building a levee. With great promptness both the Missouri and Arkansas sections of the overflowed area succeeded in obtaining from their respective legislatures at their last sessions laws by which they could form into levee districts, and when so formed to join together as one district, under one administration, for the purpose of building and maintaining the levees of the district without regard to State lines.

At present writing the levee boards and executive officers authorized by law have been organized, and steps have been taken for levying a tax. The rate of taxation is subject to a vote of the inhabitants of the district, and will be submitted to a vote on the 10th instant. Considerable opposition has been developed, and there is a possibility that no tax whatever will be levied. Should, however, the tax recommended by the levee board be adopted, the district expects to collect about $100,000 the first year.

To aid the district in constructing their levees the Commission have allotted the sum of $264,000, under the provisions of the act of July 13, 1892, to be expended in the fiscal years of 1893-'94, 1894-'95, and 1895-'96. As by far the greatest escape of water into the district takes place in the gap, 66 miles long, which exists between the high ground at Point Pleasant, Mo., and the upper end of the Plum Point Reach levee at Bear Bayou, it was proposed to expend the first year's allotment of $88,000 in beginning the levee at the upper end of the gap at Point Pleasant and extending it downstream as far as the funds would allow. The levee was advertised December 30, 1892, and bids opened January 24, 1893. Before advertising, the district officer was assured that the right of way would be freely given or promptly obtained, but after advertising and before the opening of the bids, notice was received that some of the landholders had assumed a somewhat uncompromising attitude regarding right of way and drainage questions, and having no assurance that the then local county levee board could adjust the questions satisfactorily and promptly, I recommended, for this and other reasons, that all the bids be rejected, and that the money be applied at the lower end of this gap, by extending the Plum Point Levee from Bear Bayou upstream as far as the funds would go. This project has been duly approved by the Commission and the Secretary of War, and all bids on the Point Pleasant location have been rejected and steps taken toward locating the levee above Bear Bayou. Owing to the overflow, which has prevented an examination of the locality and selection of the proper location of the levee, the work has not yet been advertised.

SECOND DISTRICT.

Hopefield Bend, Arkansas (227–230 miles below Cairo).—The revetment in this bend is over 3 miles long, extending from Mound City to Hopefield Point. The upper mile was built in the working seasons of 1882, 1883, 1884, and 1885, and has been protected from serious injury up to the present time by a sand bar which formed in front of it shortly after its construction. The lower 2 miles of the revetment, which was built in 1884, 1887, and 1888, has been subjected to the action of a very strong current since its construction, and numerous breaks have occurred since 1890, requiring extensive repairs to prevent the loss of the remaining portion of the work. The first break in this work occurred during the flood of 1890, and was repaired by a complete revetment, 762 feet long, built in the fall of 1890. Two more breaks occurred during the flood of 1891, one 2,750 feet long, at the head of the 1884 work, and the other, 600 feet long, in the 1887 work. Both were repaired in the season of 1891–'92. Five more breaks occurred during the flood of 1892, as follows, beginning with the one farthest upstream:

	Feet.
Break No. 1, length	300
Break No. 2, length	1,200
Break No. 3, length	700
Break No. 4, length	600
Break No. 5, length	1,400

To repair these breaks and to strengthen about 1,300 linear feet of mat not actually displaced, but which had become seriously weakened by decay of the brush in the vicinity of the low-water line, an allotment of $91,000 was made from the appropri-

ation contained in the act of July 13, 1892. This sum, together with an unexpended balance and a small contribution from the allotment for repairs to existing works, sufficed to complete the repairs as contemplated. An examination of these breaks at these and other points at low water suggested that the revetments have been destroyed by one of the following causes:

(1) Insufficient width, which allowed undermining by scour at the channel edge of the subaqueous mats.

(2) Want of flexibility in the subaqueous mats, which prevented them from following the scour without rupturing.

(3) Want of compactness or too great permeability of the mats, by reason of which the material under the mat is scoured out, either by direct attack by the current through them or by the return flow from the saturated strata on a receding river.

To obviate these objections as far as practicable, the plan adopted for the last season's work was to make the mats as wide as the mat barges would allow (240 feet), to use smaller brush and weave it more closely than heretofore, to make the connecting mats much thicker and with greater lap over the river mats, and to protect the bank above low water by a layer 10 inches thick of riprap stone.

Work was begun August 26, 1892, and continued under favorable conditions till its completion January 11, 1893.

Break No. 1 (300 feet long).—This failure occurred near the low-water line and carried away all the upper bank revetment. The subaqueous mat was found unbroken, with the inshore edge of the connecting mats, which was originally a few feet above low-water line, in about 15 feet of water. Repairs were made with heavy connecting mats from 115 to 180 feet wide, and a complete bank paving.

Break No. 2 (1,200 feet long).—This was in the work of 1887. The current in front of it is exceedingly strong and close to the bank. Upon examination at low water the river mat was found, in a number of places, at 50 to 100 feet out, but at other places it could not be found. The extent of caving was slight, and for nearly the entire length the top portion of the revetted slope was standing. This break was repaired with a complete revetment 1,200 feet long.

Break No. 3 (700 feet long).—This break was at the lower end of the 1887 work, and occurred just under a steamboat which had for some time been anchored along the bank. The break for a length of 300 feet and about 60 feet back occurred in twenty-four hours. Its subsequent enlargement was gradual. No river mat could be found in the middle of the break, and where found, near the ends, it was badly broken. The cave extended under the river mat of 1890, the head of which was found along the bank. Repairs here consisted of a river mat 750 feet long, with connecting mats and paving.

Break No. 4 (600 feet long).—This was in the 1888 work, and consisted of a series of small breaks along the low-water line. In places the revetment was unbroken, and at no point was the inshore edge of the river mat over 30 feet from the low-water line. Along this break is a stratum of blue clay a few feet above the zero line, with strata of fine sand above and below. Numerous springs come out of the stratum of sand above the layer of clay, undermining the sand beneath and making large holes under the brush work, allowing the mat to settle down, and at times causing ruptures in the mat where the settling is considerable. The repairs were made by heavy connecting mats of from 65 to 110 feet in width and paving.

Break No. 5 (1,400 feet long).—The first cave occurred inside of a large wharfboat lying along the bank near the upper end; a pocket 300 feet long and 75 feet back went out in a day. Afterward another pocket caved near the lower end, and both were subsequently enlarged until they nearly connected. The stratification of the bank described under Break No. 4 occurs here. The repairs made were 1,470 feet of complete revetment.

In addition to the above, 1,000 feet of the revetment above Break No. 4 and 300 feet of revetment below it were strengthened in the vicinity of the low-water line by mats 50 to 95 feet wide and some additional ballast on the upper bank work. There were no actual breaks in the revetment, but the brush work was decayed, more or less broken and displaced, and but lightly ballasted.

The work of the season included *grading*, length of bank 3,650 feet, contents 71,000 cubic yards; *wide river mats*, length 3,470, number of squares 8,253, length of bank covered 3,420 feet; *connecting mats*, length 6,200 feet, number of squares 5,416; *paving*, length of bank covered 4,970 feet, number of squares 3,120.

The average cost was—

Grading	per cubic yard	$0.044
Wide-river mats	per square	3.653
Connecting mats	do	5.893
Paving	do	11.70
Reballasting old work, 590 squares	do	5.50
Total cost of work		101,639.36

Brush and poles were obtained by contract at 95 cents per cord for the brush and $1.50 per cord for the poles. The deliveries were at times insufficient, causing delays and loss.

Stone was obtained by contract from Williford, Ark., over the Kansas City and Memphis Railroad, one-half on the top of the bank and one-half on barges. The deliveries were prompt. The price paid was $1.85 per gross ton on bank and $1.70 on barges. The stone was limestone, of variable quality. From careful determinations, made by measuring the displacement of several barges loaded and empty, the weight of the stone was found to be 2,496 pounds per cubic yard.

For further details, see accompanying report of William M. Rees, the assistant engineer in local charge of the work.

As a preliminary step toward investigating the effect of the river current on a revetted bank, and ascertaining, if possible, the causes of failure in the revetments, the lower two-thirds of the revetment in this bend was sounded along sections 100 feet apart during the low water of 1892. The soundings were made with great care. Two barges, each 130 feet long, were lashed end to end and moored at a right angle to the bank along the section to be sounded. The soundings were made 10 feet apart along the upstream side of the barges, the positions of the soundings being indicated by marks on the sides of the barges. The distance of each sounding from the shore end of the barges was carefully measured, as was also the horizontal distance from the shore end of the barges to a permanent base line on shore. Given these measurements and the stage of water at the time the soundings were made, it was possible to construct very accurate profiles of the revetment, which can be used in connection with similar profiles to be made in the future for the purpose of ascertaining any changes that may take place in the shape or position of the mats at any point.

Comparative soundings were made over a number of sections along the old 1888 work in March, 1893, at a stage of river between 26 and 28 feet, and in a very swift current. Compared with the soundings taken last year at low water they appear to indicate that the mat has settled in places in the vicinity of the low-water line, and that the whole of the river mats at a few points have settled; but the later soundings are not submitted as conclusive as to the changes noted, since the current was too swift to permit soundings to be taken with any degree of accuracy. The extent of the settling can only be determined by an examination at next low water. There are known to be at present four new breaks in the stone work, but their extent cannot be ascertained until the water recedes.

To repair these and to renew the old revetments where wide mats have not been placed since 1890 an allotment of $100,000 has been made from the appropriation contained in the sundry civil bill of March 3, 1893. The work will be done during the coming low-water season.

To ascertain if the frequent failures of the revetment in this bend might not be due to a specially treacherous formation of the bank, 7 borings have been made 1,000 feet apart along the lower 7,000 feet of the revetment. The average depth of 6 borings was about 130 feet below the top of the bank, and 1 boring was carried to to a depth of 160 feet. Samples of the borings have been arranged and a full report will be prepared at an early date.

Memphis Harbor (250 miles below Cairo).—The outlying sand bar and the causes which have led to its formation, are fully described on page 3587 in the Annual Report of the Chief of Engineers for 1891. During the low water of 1890 the sum of $4,802.33 was expended in maintaining a channel through the bar to the Memphis Elevator. The channel so dredged was filled by deposit the following high water to a higher level than before, and in 1891 an allotment of $15,000 was made and expended in again keeping open this channel. Though the traffic to the elevator was at no time suspended in 1891, the maintenance of a channel to the elevator proved of but little value, as all but one of the boats landing at the elevator had gone to the bank on account of the extreme low water of that season.

The heavy deposit on the bar, which occurred during the flood of 1892, made it impracticable to attempt to reopen this channel again, and no work was done that season. No further dredging is recommended at the present time. The bar appears to have not yet reached its greatest development. In 1890 the tail of the bar had dropped down to a point 150 feet above the paved levee. During the flood of 1891 it advanced downstream about 450 feet, overlapping the paved levee about 300 feet, and a further advance of 160 feet took place during the flood of 1892.

The protection of the city front consists of 9,500 linear feet of revetment, of which the upper 7,500 feet is continuous mattress and the lower 2,000 feet is of the spur-dike system. No injuries have been noted to the spurs or the continuous revetment above it, both of which remain in serviceable condition.

Nonconnah Rock (236 miles below Cairo).—This so-called rock is located opposite the mouth of Nonconnah Creek and 3 miles below the Memphis Bridge. The distance from the Tennessee shore is about 700 feet and from Presidents Island shore 2,000

APPENDIX 4 A.

REPORT OF ASSISTANT ENGINEER W. M. REES ON IMPROVING MISSISSIPPI RIVER AT HOPEFIELD BEND, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 22, 1893.

CAPTAIN: I have the honor to submit my report on improving Mississippi River at Hopefield Bend, Arkansas, during the season of 1892 and 1893.

Description.—The lower portion of the revetment, 2 miles long, was built during the seasons of 1884, 1887, and 1888. The first break in this work occurred during the high water in the spring of 1890, near its middle, and was repaired by a complete revetment 762 feet long, built in the fall of 1890. The flood of 1891 caused breaks above this repair work to the extent of 3,350 linear feet, which were repaired during the season of 1891-'92. The remainder of the original work was in a weak condition, especially near the low-water line, and some repairs were made to the weakest places during the same season. It was then thought that all of this work needed a general strengthening. The flood of 1892 proved this to be necessary, for, upon its subsidence, breaks appeared at a number of places, an examination made on July 22, 1892, showing five distinct breaks. These are described as follows:

Break No. 1.—From station 18 to 21, 300 feet long. This was where the complete revetment of 1891 ends on the old work of 1887. The failure occurred near the low-water line, and carried away all the upper bank revetment. The lower work was found unbroken, with the inshore edge of the connecting mats, which was originally a few feet above the low-water line, in about 15 feet of water. Repairs were made with heavy connecting mats, from 115 to 180 feet wide, and a complete bank paving.

Break No. 2.—From station 28 to 40, 1,200 feet long. This was in the work of 1887, and was a stretch of bank projecting riverward beyond the average bank line, the projection being caused by the caving below in 1890, and above in 1891; consequently the high-water current along this location was exceedingly strong and near the bank. Upon examination the river mat was found in a number of places at from 50 to 100 feet out, but at other places it could not be found, so it is uncertain whether the failure was by undermining or by breaking near the low-water line. The extent of caving was slight, and for nearly the entire length the top portion of the revetted slope was standing. This break was repaired with a complete revetment 1,200 feet long.

Break No. 3.—From station 43 to 50, 700 feet long. This was at the lower end of the 1887 work, and immediately above the repair work of 1890. It was the first break of the flood of 1892, and occurred just under a steamboat which had for some time been anchored along the bank. The break, for a length of 300 feet, and about 60 feet back, occurred in twenty-four hours, and the subsequent enlargement was gradual. No river mat could be found in the middle of this break, and where found, near the ends, it was badly broken. This cave extended under the river mat of 1890, the head of which was found along the bank. Repairs here consisted of a river mat 750 feet long, connecting mats and paving.

Break No. 4.—Between Stations 68 and 74. This was in the 1888 work, and was a series of small breaks along the low-water line. In places the revetment was unbroken, and at no point was the river mat over 30 feet out from the low-water line. Along this break is a stratum of blue clay a few feet above the zero line, with stratas of fine sand above and below. Springs come out over the clay, undermining the sand beneath and making large holes under the brush work, letting it down and at times causing breakage. The repairs here made were connecting mats of from 65 to 110 feet width and paving.

Break No. 5.—From Stations 77 to 91, 1,400 feet long. The first breaking occurred inside of a large wharf boat lying along the bank near the upper end. A pocket 300 feet long by 75 feet back went out in a day; afterward another pocket caved near the lower end, and both enlarged until they nearly connected. The stratification described under Break No. 4 occurs here. The repairs made were 1,470 feet of complete revetment.

Between Stations 58 to 68 and 70 to 77 the revetment near the low-water line was in bad condition at numerous places, the brush work being decayed, more or less broken and displaced, the ballasting light, and below the low water the slope was often as steep as 1 on 1½. This entire stretch was covered with connecting mats from 50 to 95 feet wide, and the upper slope reballasted.

The construction of the original revetment was as follows: River mats of the usual woven type were 200 feet wide; generally sunk with their inner edge along zero contour, but in some places along the 1888 work. The inner edge is about at

(304 to 307 miles below Cairo), 12,900 feet in sections 60–62 and 63 (309 to 312 miles below Cairo), 16,700 feet of levee in the vicinity of Malones Landing (356 to 358 miles below Cairo), and 11,900 feet below Pushmataha Landing (360 to 365 miles below Cairo). Also in constructing a new loop 3,483 feet in length below Lake Charles (358 miles below Cairo), where the old levee is threatened by a caving bank. The levees were advertised December 30, 1892, and bids opened January 24, 1893. Formal acceptance of bids was deferred till after sundry civil bill of March 3, 1893, containing the appropriation, had become a law. One of the successful bidding firms having failed to make their contract, the levee awarded them has been re-advertised informally and contracted for with the successful bidder of the second letting. These levees are to be completed January 1, 1894.

The total amount of work contracted for under the appropriations for the fiscal year of 1893–'94 comprises the enlargement and construction of 11¼ miles of levee, containing 577,000 cubic yards of earth, and costing $89,902.50. The following table shows the amount of work done by the local levee board and the United States in this district to date:

	Cubic yards.
Aggregate yardage of levees to June 30, 1892	7,413,195
Added by United States up to May 1, 1893	503,448
Added by others up to May 1, 1893	439,106
Total to May 1, 1893	8,355,749
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	75,000
Aggregate remaining May 1, 1893	8,280,749

Upper White River levee district (306 to 340 miles below Cairo).—This district comprises the upper half of the narrow belt of overflowed land, about 10 miles wide, which lies between the Mississippi and White rivers and below the foot of Crowleys Ridge. The lower third of the district is but sparsely settled on account of the frequent overflows. The upper two-thirds, namely, that above Yellow Banks Bayou, constitutes the local district known as Cotton Belt Levee District No. 1. Its area comprises 157,000 acres of land, of which 50,000 are under cultivation. The assessed valuation of all property, real and personal, is $1,058,000, and its real value, not including the town of Helena, is estimated at $1,898,000, or $86,000 for each mile of existing levee in the district.

The existing levee begins at the foot of Crowleys Ridge above Helena, and extends downstream 22 miles to Yellow Banks Bayou. The grade varies from 1.5 to 3 feet above highest water, except along the lower two miles above Yellow Banks, which is much below a safe grade. By the allotments of August 4, 1892, this district received $50,000 for the fiscal year ending June 30, 1893, and $53,000 for each of the three years ending June 30, 1894, 1895, and 1896.

Believing that the local levee board was abundantly able to enlarge and care for the short levee in the district, the first year's allotment has been expended in enlarging the existing levee above Yellow Banks, which was much below grade, with the view of extending this levee southward from year to year, as appropriations become available, and to eventually close the White River front by forming a junction with the levees of the Lower White River levee district, which would at the same time be extended northward with the same object in view.

Bids were opened October 10, 1892, and 146,000 cubic yards of earthwork was awarded at 27 cents per cubic yard. After some delays, which were unavoidable, the contractors commenced work early in November. The work proved exceedingly difficult, and, hindered by boggy ground, heavy rains, and, finally, by the overflow, the contractors have succeeded in doing only about one-half of the work. The contract has been extended till August 1, 1893. The following table shows the amount of work done by the local levee board and the United States to date:

	Cubic yards.
Aggregate yardage of levees to June 30, 1892	1,374,191
Added by United States up to May 1, 1893	59,727
Added by others up to May 1, 1893	94,000
Total to May 1, 1893	1,527,918
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	.....
Aggregate remaining May 1, 1893	1,527,918

The second year's allotment, as approved by the Commission and the Secretary of War, is to be expended in extending the levees southward as far as the funds will go, and the levee to be built has been contracted for, to be completed January 1, 1894.

Lower White River levee district (340 to 385 miles below Cairo).—This district comprises the lower half of the narrow belt of overflowed land between the Mississippi

and White rivers. Above the Desha County line the country is but sparsely settled, on account of the frequent overflows. Below the Desha County line the district includes an area of 26,608 acres, of which 14,238 are under cultivation. The assessed valuation of all property, personal and real, is $193,500, and its real valuation is estimated to be about $568,000.

Not including the private Circle levee, which is maintained by private subscription, this district contained at the date of last Annual Report 19 miles of levee, beginning at a point below Henrico, Ark., and extending eastward and northward to the middle of the bend of Island 68. The upper part of the line above the Desha-Phillips County line, which was new levee, had been raised to a grade of 4 feet above highest water, while below the county line the grade was, on an average, only 1½ feet above high water. Under the allotments of August 4, 1892, this district received the sum of $300,000, to be expended $75,000 each year for the four fiscal years ending June 30, 1896. The first year's allotment has been expended in part in raising and enlarging 30,630 feet, or about 5¾ miles, of the existing levee between Laconia and the county line to a grade of 3 feet at Laconia and 4 feet at the county line, and in extending the Carson Loop northward 11,800 feet by a new levee. The work was divided into five contracts and bids opened October 10 and October 24, 1892.

All the levees have been completed. The prices varied from 15 to 15¾ cents per cubic yard for the enlargement work, and from 16½ to 19¾ for the new levees.

The total work of the season comprised 138,612 cubic yards of enlargement and 196,931 cubic yards of new levee, costing, including extras, $59,315.56.

The second year's allotment will be expended in extending the Carson Loop northward as far as the funds will go, and the work to be done has been contracted for to be completed January 1, 1894.

The following table shows the work which has been done by the local district and the United States in this district:

	Cubic yards.
Aggregate yardage of levees to June 30, 1892	855,023
Added by United States up to May 1, 1893	335,615
Added by others up to May 1, 1893	10,000
Total to May 1, 1893	1,200,638
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	
Aggregate remaining May 1, 1893	1,200,638

PLANT.

Steamers.—New stacks have been placed on steamer *Titan* and cylinder timbers stiffened by athwartship braces.

Steamer *Graham* was docked, hull repaired and calked, cabin repaired and painted, furnace reconstructed, and a new wheel and cylinder timbers placed on her.

Steamer *Kirns* had cylinder timbers, hog-chain braces, transom, stem, and rudders renewed. This boat was sunk in an ice gorge at Belmont, Mo., on January 19, and proved a total loss, the boiler and part of machinery only being saved.

The *Itasca* and *Abbot* received minor repairs. The former has an iron hull, the bottom plates of which are very thin, and will require renewal in the near future.

The two large hydraulic graders were docked and repaired; the compound low-pressure pumps on one (No. 4) being badly damaged, were removed and replaced by four small pumps taken from the pile-drivers.

The two machine boats were docked and hulls thoroughly repaired.

Two quarter boats and three barges were also docked, repaired, and calked.

Minor repairs were made to 7 pile-drivers, four quarter boats, 5 mat boats, 4 mooring barges, 4 decked barges, and 4 flats. One district barge was cut down and converted into a flat, and the engine on sand-pump boat removed and sent to the fourth district for use there.

Repairs were also made to skiffs, tools, appliances, etc.

Eight model barges were loaned, by the courtesy of Maj. A. M. Miller, Corps of Engineers, and were used during the working season in towing stone from quarries.

The steamer *Minnetonka* and 43 barges were received by transfer from the general service. Of these barges, 15 only are in serviceable condition for hauling loads. The balance are quite old, having been built from nine to ten years ago.

Two mattress ways and two mooring barges were purchased of the Kansas City and Memphis Bridge Company. These were constructed from coal barges.

The detailed cost of the foregoing repairs is shown in the report of Assistant C. W. Sturtevant.

Four barges were lost by sinking and twelve have been condemned and dropped from the returns.

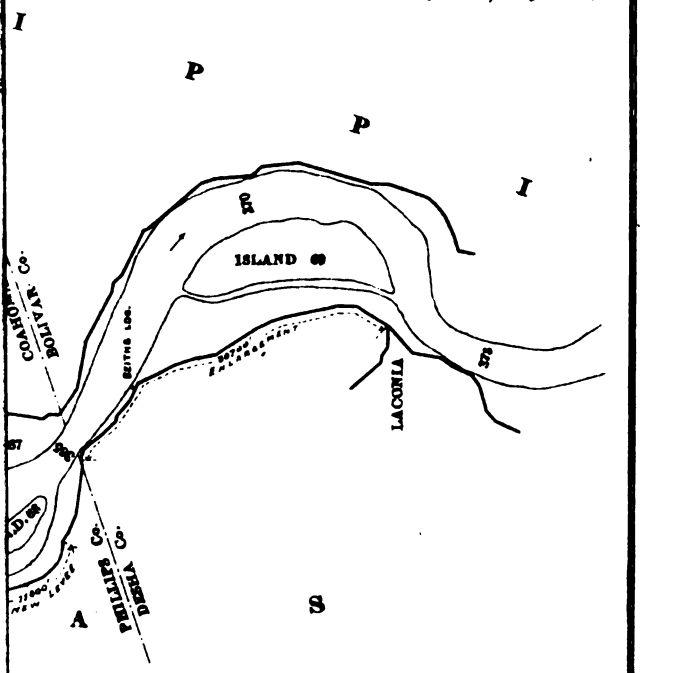
locations of levees built and enlarged
econd district during the season of
1892 - 93.

SCALE OF FEET.

NOTE. Heavy black lines represent existing levees on which the new work is indicated.

To accompany annual report for the fiscal year ending June 30. 1893

S. W. Roessler
Captain of Engineers.



Eng 93

Contracts have been entered into for the construction of 29 decked barges 120 by 30 by 6 feet; 2 mattress barges 160 by 32 by 5 feet, and one for experimental dredge. Work on these has already begun, and it is expected that they will all be completed in time for use at the opening of the ensuing working season.

HIGH WATER OF 1893.

The relative heights of the high water of 1893, as compared with the highest known water at the various points in the First and Second districts, are shown in the following table:

Station.	Distance from Cairo.	Highest known.		Highest water, 1893.		Above or below highest known, 1893.
		Date.	Gauge.	Date.	Gauge.	
			Feet.		*Feet.*	
Cairo	0	Feb. 27, 1883	52.17	May 8–12	49.3	—2.87
Belmont	21	Feb. 23, 1884	45.80	May 10	43.8	—2.00
New Madrid, Mo.	69	Feb. 24, 1884	41.52	May 11	38.6	—2.92
Cottonwood Point	123	Feb. 28, 1883	37.85	May 13	36.5	—1.35
Fulton	175	Mar. 1, 1882	36.69	May 15	34.6	—2.09
Memphis	232	Mar. 15, 1890	35.60	May 17	35.2	—0.4
Mhoona	275	Mar. 8, 1883	40.20	May 25	37.9	—2.3
Helena	307	Apr. 30, 1886	48.10	May 25	48.0	—0.1
Sunflower	353	Apr. 1, 1890	42.90	May 27	42.9	—0.0

As seen from the table the river has not reached an excessive height between Cairo and Memphis, but from Memphis down to the lower limit of the Second District at White River it closely approximated the highest floods known, being four-tenths of a foot below the highest recorded flood at Memphis, one-tenth below at Helena, and the same elevation as the 1890 flood at Sunflower Landing. At a point near Westover, 13 miles below Helena, a voluntary gauge observer reports a height of 3 inches above the highest flood known.

At yet there have been no crevasses in the First and Second districts, and as the river has fallen about 3 feet at Helena, it is confidently expected there will be none.

The levees in Arkansas, viz, those in the Upper and Lower White River Levee districts, have been held only by the exercise of the greatest vigilance and prompt and timely repairs of defects before they had assumed alarming proportions. To secure the necessary vigilance on the part of the people, Government aid was granted only in the event that the local authorities complied with two essential requirements in levee protection. First, that the levee be thoroughly patrolled, to guard against injuries to levees by trespassers, to keep off stock, to prevent landing of boats, etc.; and second, that the levee be divided into small lengths and each one put under the charge of a competent man, to inspect it, to discover and locate weak places, to make immediate repairs, if necessary, or, if time permits, to report to the engineer in charge for repair by a regular repair force.

Realizing the advantages and security which this method of coöperation afforded, the local authorities have carried out their part of the programme with energy, and with the aid extended by the Government, have been able to hold their levees against one of the most threatening floods ever experienced, and have averted crevasses which would certainly have occurred with any less degree of vigilance.

In the Upper Yazoo District the levees are under the control of a very efficient local levee board, and the only aid extended so far by the Government has been in the way of purchase of material, the local board providing the labor.

Respectfully, submitted.

S. W. ROESSLER,
Captain of Engineers.

Gen. C. B. COMSTOCK,
President Mississippi River Commission.

the 10-foot contour, making the width below the zero line about 175 feet. Connecting mats were of similar build, and were made continous with the bank brush work; the latter had a double layer of brush, and was ballasted with stone of sizes from 20 to 200 pounds, the quantity used being less than 1 ton per square, as against over 3 tons now used in paving, so that spaces amounted to fully 75 per cent.

The weak points in this revetment, as observed, are: First, insufficient thickness of connecting mats. These cover a belt extending from 15 to 20 feet below low water to 5 to 10 feet above. The slope below low-water is frequently steep and the bank material mostly fine sand. Scour has frequently been observed under them, caused by the action of springs and wave wash of wind and passing boats. Second, insufficient ballast on bank work, exposing the underlying brush to air and moisture, and causing rapid decay. After three years, much of the brush work is thoroughly rotten. Third, insufficient width of river mats. In places where these do not reach practically to deep water, the work may fail by undermining. Fourth, it is probable that scour occurs through the mats at such places where the interstices are too large, and the underlying material easily washed.

Plans.—To make the repairs above described, the plan was: First, to make the river mats of sufficient width to practically reach deep water, being careful to leave no large openings in the work. Second, to make connecting mats much thicker and with greater lap on river mats. Third, upon a graded bank, with slope not steeper than 1 on 3, to place 3 inches of crushed stone and 6 to 8 inches of small riprap, closely packed.

Construction.—Work began immediately after the arrival of the first tow of plant, August 26, 1892, and was practically finished January 11, 1893. The season was favorable, and the river kept at a low stage, remaining below the 6-foot stage until December 15, when it began rising, reaching the 15-foot stage on December 24, and continuing above the 10-foot stage for about three weeks, when it began to fall, and reached the 1.8-foot stage on January 24. The first time lost by rain was on October 31, and total time lost by rain nine days. Ice began running on January 13, and continued eleven days, and again ran for two days on February 9 and 10.

Labor.—The supply was at all times plentiful. Whites, subsisted by the Government, were employed in nearly all the responsible positions. Most of the common laborers were negroes, and subsisted themselves. They were good laborers, steady, and submissive, and preferable to the shifting white laborers formerly employed. The price paid was $1 per day and subsistence, or $1.25 per day to non-subsisting labor. The day worked was eight hours, and the price the same as paid in the vicinity for ten hours' work. The maximum force employed was 245 common laborers.

Materials.—Brush and poles were obtained by contract at 95 cents per cord for the former and $1.50 per cord for the latter, and the source of supply was from 6 to 25 miles above the work. The deliveries were at times insufficient, causing delay and loss.

Stone was obtained by contract from Williford, Ark., and delivered—one-half on top of bank and one-half on barges. The deliveries were prompt. The price paid was $1.85 per gross ton on bank and $1.70 on barges. The stone was limestone of variable quality, some containing much fine silica and frequently flint nodules. The riprap was in pieces from 20 to 100 pounds in weight, and crushed stone of dimensions to go through a 2½ inch ring. Fifty-eight car loads, with weights determined, were loaded on four barges and carefully measured. The average weight per cubic yard thus obtained was 2,496 pounds. The measurements were checked by measuring the displacements of the barges, loaded and empty. This gave the weight of 1 cubic foot of river water 63.48 pounds, and 1 cubic yard, as measured, displaced 39.3 cubic feet of water.

Grading.—The bank was graded to a slope of 1 on 3, or flatter, and in the pockets this slope was not carried to the top of a bank, a shoulder 6 to 8 feet high being left.

Hydraulic grading began August 29, and the last grader finished work November 26. Three graders were used, being the same plant as employed last year, viz, grader No. 40, having a Gordon & Maxwell condensing duplex pump with 20-inch steam cylinders, 10-inch plungers, and 12-inch stroke, pile-drivers No. 20 and No. 59, each having Worthington compound duplex pumps with 16½-inch and 10-inch steam cylinders, 6½-inch plungers and 10-inch stroke. Grader No. 40 threw two streams and the others one each. The hose was 3-inch diameter, 8-ply rubber, each line 150 feet long, with nozzles seven-eights inches diameter. When properly working a water pressure of 160 pounds per square inch at the pumps was maintained on all the graders, with steam pressures of 80 to 85 pounds.

Prior to grading the bank was cleared of timbers, drift, and old mat work, and after grading with the pumps the grade was dressed by hand and stumps removed by blasting. This work cost nearly as much as the grading proper.

ing was at or near the low-water line, leaving both upper and lower portions of the revetment in place. The bank here, being steeper and more irregular in slope, the revetment fails either at weak points, where it may have been broken by bending over obstructions, or by scour through it. I would, therefore, respectfully suggest:

That the grade be reduced, say to 1 on 4, especially at the lower part of the slope; that the brush work be made much thicker for a distance of 150 to 200 feet out; that more brush work be used under the paving, where the material is fine and there is a tendency to uneven settling of the pavement or to scour through it; that the river mats be made wider, to prevent any possible undermining from the outside, and that crib dikes of sufficient length and height be placed along such portions of the bank where the slope under the zero contour is steeper than 1 on 3.

The above scheme would require a river mat 300 feet wide, another on top of this 150 to 200 feet wide, a connecting mat about 75 feet wide and 1 foot thick, and, along steep banks, a crib about 200 feet long by 12 feet high as a maximum for each 250 feet of bank. The two river mats could be more rapidly placed (I think as cheaply), and they would certainly be better than to increase the thickness of one river mat with additional layers of brush.

The cost for a complete revetment of this description would be, per linear foot:

River mats, 5 squares, at $3.50	$17.50
Connecting mats, ½ squares, at $6	4.50
Paving, 75 square feet, at 10 cents	7.50
Cribs, 200 cubic feet, at 3 cents	6.00
Total	35.00

Accompanying this report is a map of the work and a tabulated statement of expenditures.

Respectfully submitted.

W. M. REES,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

APPENDIX 4 B.

REPORT OF ASSISTANT ENGINEER AUG. J. NOLTY ON OPERATIONS AT PLUM POINT REACH.

UNITED STATES ENGINEER OFFICE,
Amelia, Ark., April 25, 1893.

CAPTAIN: I have the honor to submit my report of operations at Plum Point Reach for the ten months beginning with June 1, 1892, and ending March 31, 1893:

The only work in progress at the beginning of the period was unloading stone at Ashport Bend and Elmot Chute as fast as received from the quarries. This work was continued until September, by which time there had been unloaded 31,528 cubic yards of stone and 1,186 cubic yards of spalls.

There were received during the same period 10,538 cubic yards, the excess of receipts over the quantity unloaded representing stone used on the works directly from barges. At such times, when no stone was on hand, the unloading party were employed in clearing a strip of bank in Ashport Bend, along the site of contemplated operations.

Revetment, Ashport Bend.—Three thousand two hundred and fifty feet of the upper part of this actively-caving bend had been revetted the previous season. The work of extending this revetment downstream was begun on the 1st of August, upon which date a small party was put in the field to cut brush and poles sufficient to begin construction of a floor mat for Pocket No. 1, formed just below the termination of the previous year's work. The caving, which usually takes place at the foot of a revetment, had formed here a pocket 120 feet deep, measured from the general bank line back and 400 feet long longitudinally, forming a crescent-shaped pocket. Four mattresses were constructed and sunk so as to entirely cover the bottom, and extending outstream far enough to be well overlapped by the regular river mat to be subsequently built. The part of the bank above water was revetted up to the mid-stage line.

Most of the brush and poles used for this work were obtained by hired labor, as, owing to the still high stage of the river and consequent uncertainty as to when full operations would begin, it was not deemed advisable to order the brush contractors out.

The cost in detail was:

Labor and subsistence	$7,498.59	Superintendence	$1,257.24
10,957 tons stone	20,130.59	Towing	565.75
395 cubic yards gravel	295.95	Miscellaneous expense	211.50
Miscellaneous materials	8.75		
Clearing and grading	6,520.28	Total	36,488.65

Cost per square foot, $0.117; per square yard, $1.05.

Repaving old work.—The low water exposed many bare places in the work of 1891, which had been constructed at a higher stage. About 1,000 linear feet of this was repaved, and 1,730 linear feet along the old revetment. The total work of this kind covered was 59,000 square feet to an average thickness of 6 inches.

The cost was:

Labor	$611.50
1,425 tons stone	2,422.50
Superintendence	150.00
Towing	60.00
Total	3,244.00

Cost per square foot, $0.055.

SUMMARY.

Work done.	Cost.	Cost per unit.
River mattresses, 3,470 linear feet (8,253 squares)	$29,089.85	$3.033 per square.
Connecting mats, 6,200 linear feet (5,416 squares)	31,916.66	$5.893 per square.
Paving, 312,000 square feet	36,488.65	$0.117 per square foot.
Repairing old work, 59,000 square feet	3,244.00	$0.055 per square foot.
Total cost	101,639.36	

SURVEYS AND EXAMINATIONS.

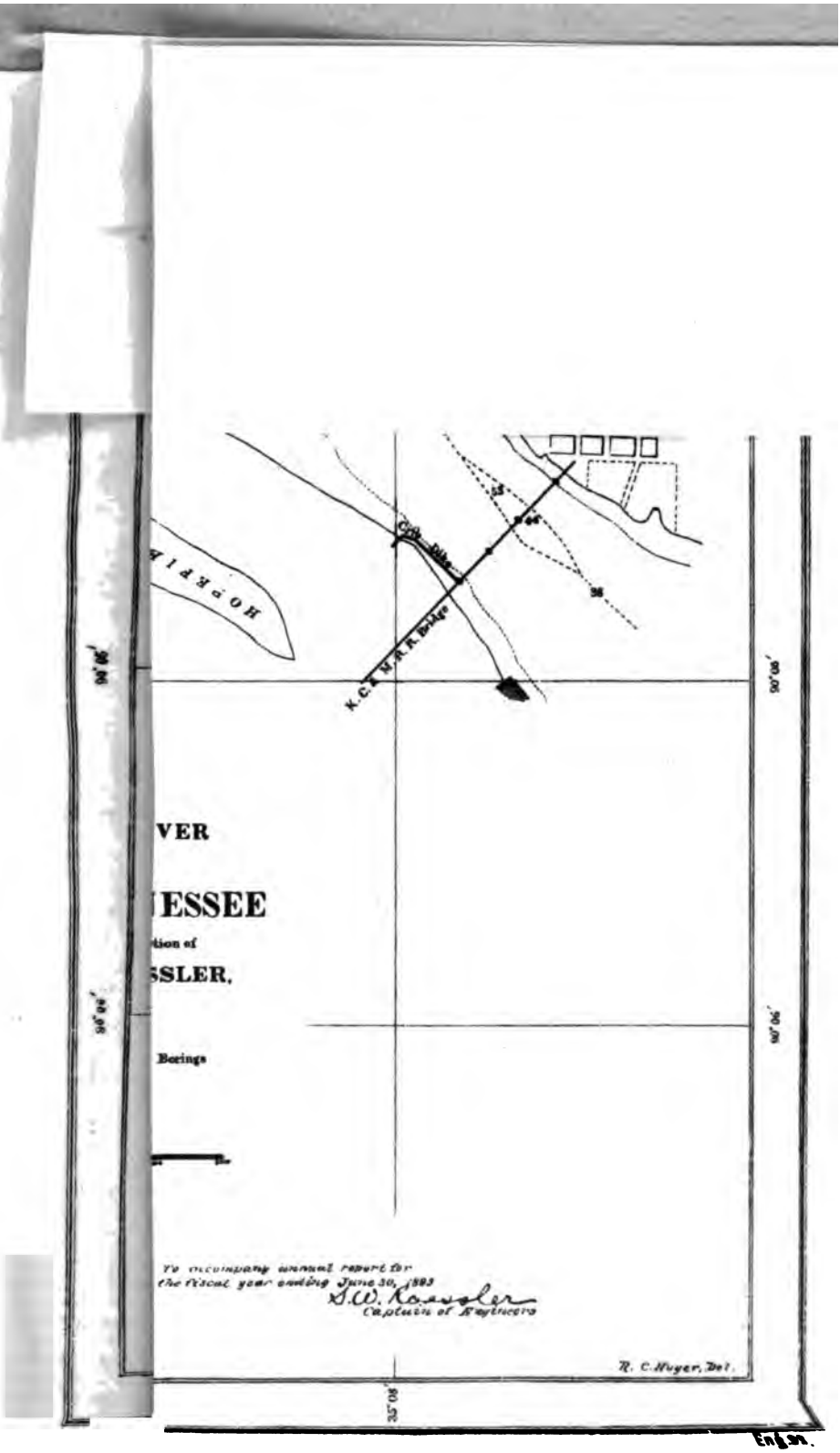
Soundings.—A line was run on top of bank, connecting with all stations of last year's surveys not lost by caving. Soundings were taken on sections 100 feet apart, and perpendicular to bank line, and have been referred to low water and plotted on the map. The manner of taking soundings was as accurate as practicable; a pair of barges 270 feet long were lashed end to end and placed along the section line, and soundings taken with a carefully graduated and checked lead line at each 10 feet, and at stages between 3 and 5 feet, and when the current was very slack. The cost of making this survey was $410.82.

Comparative soundings were made over a number of sections along the old 1888 work in March, 1893, at a stage of river between 26 and 28 feet, and in a very swift current. They show greater depths of from a few to 20 feet, the greatest increase being near the low-water line. That the work is broken in some localities is shown by caving along the bank. At other places it appears to be unbroken at the low-water line, but to have settled. At two places the failure appears to have occurred in the paving just above the connecting mats, and where the bank is of sand. That the river mats have settled is evident, but whether this is due to undermining and slipping riverward or to scour through the mats can only be determined by careful examination at a lower stage of water. All the sections showing decided change are along subaqueous revetment of 1888. Not enough sections were re-sounded over new river mats to make a comparison.

There are four breaks along the revetment at this writing, but their nature and extent can not be determined with much accuracy until the water recedes. They are all along the old (1888) revetment, and each break appears to be about 300 feet long, but the present high water will, beyond doubt, increase their extent.

Borings.—Tools and appliances for making test borings were made and work started on January 2, but after a few days was discontinued, to make other tools, and, on account of bad weather, not resumed until January 23. This work is still in progress, and will be reported upon when finished. Sufficient borings have been made to show that the bank formation is principally sand, varying in fineness in different holes, and always finer near the low-water line than at greater depth, where more coarse gravels and clays are found.

The recent failures indicate that a decided change should be made in the manner of construction. While there is no definite proof to show that failure is due to undermining from the outside, many cases have been observed where the first break-


Hoppin
K.C.S. & M.R.R. Bridge
City Mine
55
64
36
90.00'
90.00'
90.00'
90.00'
35.08'
VER
ESSEE
tion of
SSLER.
Borings
To accompany annual report for
the fiscal year ending June 30, 1883
S.W. Roessler
Captain of Engineers
R. C. Huyer, Del.

by doing away with all sharp angles where the diaphragm joins the sides. At this juncture all cracks here hitherto originated in the original cylinders of both the Dean and Davidson pumps, while the new ones are still perfect. Both sets of pumps were originally designed for a pressure of 200 pounds per square inch, but this had been reduced to 175 pounds, which may be assumed as the safe limit.

Grading along sections No. 2 and No. 3 proceeded in advance of mattress construction, and with fair results both as to economy and perfectness of slope, but as the lower end of the latter section was reached, the outcrop of the strata changed and much sand was encountered, and in consequence but a poor slope, requiring much hand dressing, was obtained. Finally, as grading proceeded downstream, the results were so unsatisfactory that it was decided to abandon grading in advance of the mattress construction and grade only where the mats had been previously sunk. This should be adopted as a rule, for it has been demonstrated here that no matter what the composition of the bank, a good slope can be obtained after the river mat is sunk. At section No. 1, where the composition of the bank is closely allied to that at Mud Point, grading was done after the river mat was down. At first the results were discouraging, as the lower strata of sand caved and washed badly, but upon a continuance of the work it was found that as soon as the voids under the mat were filled up by the washed-down material caving ceased and a good slope was obtained.

The progress of grading, while slow when compared with that made at other localities on the Reach, was satisfactory when the physical features of the bank operated upon are considered. The main cause of the slow progress was the number of stumps encountered on all the sections except No. 5. On section No. 3 the stumps on a piece of graded bank measuring 77 by 300 feet numbered 74, varying in diameter from 5 to 13 inches, and this was by no means the most thickly wooded portion. These stumps penetrated as much as 15 feet below the surface, and in addition there were a large number of stumps uncovered that were evidently the remains of a former cypress swamp. Section No. 5 was comparatively free of timber.

In order to expedite this class of work, two Wells lights were put in use, one for each grader, and by their aid and with double crews on each machine, night-work was done. This began on September 28, and continued until October 26, by which time grading had advanced sufficiently to warrant a discontinuance of night-work. The lights worked well, required little attention and gave ample light, with a consumption of 1¼ gallons of oil per hour. On November 29, grader No. 4 was transferred to Daniels Point, where it continued until the close of the season.

Paving.—In the early part of the season riprap was laid, as has been customary hitherto; that is, to a uniform thickness of 10 inches. This was subsequently changed by your orders to 12 inches or more for about 5 feet above the zero line, thence tapering to 6 inches at the 15-foot contour, to which latter height only all paving was to be carried.

Some soft places along the foot of slope were first covered with brush foundation mats, and all depressions of any magnitude were filled up with brush, this being always raised above the general level so as to allow for settlement and compression. There are a few places, principally at sections No. 8*a*, No. 8*b* and No. 5, where, owing to the advent of high water, the paving was not carried up quite to the 15-foot contour.

Spur dikes.—Of these there were three constructed, two in front of the Mud Point bank and one in pocket No. 2. The object of placing these spurs there was to break up the strong eddy existing there, which result has in a manner been accomplished, though the dikes are not yet completed. No. 2 requires extension outstream 50 feet and wattling for the entire length. No. 3 requires wattling and slight extension inshore, and No. 4 requires wattling. The dikes are constructed of two rows of piling 12 feet apart, strengthened at the outstream ends by an "L," the piles being placed 8 feet apart, and the whole structure well braced and turned. All piles used are cypress. Where the dikes have the low-water contour on their inshore extensions, shore mats 50 feet wide and running up to top of bank were laid. Through them the piles are driven. No. 1 has not been begun.

Test borings.—This work, begun on March 22, is now in progress along the Mud Point bank. A separate report of this work will be made upon its completion.

REVETMENT AT DANIELS POINT.

River mat No. 1.—Repairs to this work, which had suffered serious damage during the previous flood, were begun on October 8, by commencing the construction of a river mat 240 feet wide, its inner edge lying along the low-water line. Considerable preliminary work, such as clearing away drift and old revetment, driving abatment, driving anchor piles, getting out mooring cables, etc., had to be done. The plant for the mat was swung into position for weaving on the 13th. When about 700 feet of its length had been completed it was found that the mat was beginning to sag badly where it had been ballasted, this sagging being due to deposits of silt accumulating upon the mat. This sagging continuing to such a degree that it was feared the mat might be strained too much, it was sunk on the 31st, after a

length of 800 feet had been obtained. This mat was intended to cover the upper 1,000 feet of the damaged work. Its sinking before that length had been obtained was merely a precautionary measure.

River mat No. 2.—Immediately after sinking No. 1, this mat was begun high enough above the foot of the former to make the usual 25-foot overlap. It had to be curved around a projecting point of the old work, which compelled us to move the inner edge considerably beyond the low-water line, and afterwards to construct a wide connecting mat. This point lay 250 feet below the head of No. 2. Construction proceeded slowly, owing to shortage of the brush supply and bad weather. The mat was sunk on November 29. Its dimensions are, length 1,110 feet by 242 feet.

River mat No. 4.—This mat, which was to cover the farthest downstream fault, was begun December 19, the construction of river mat No. 3, which was to cover the break between the foot of No. 2 and head of No. 4 having been postponed for reasons given farther on. Progress of construction was slow on account of scarcity of labor and of brush, mainly due to the last cause. Its length is 613 feet and width 240 feet. It was sunk on January 6.

River mat No. 3.—Immediately after the sinking of river mat No. 2, the construction of fascines for this mat was begun. These were made of small brush, were from 50 feet to 100 feet long and 12 inches diameter. They were tightly compressed and wired together every 3 feet. These fascines were to form the warp of the mattress, pairs of longitudinal strand cables spaced 8 feet apart forming the woof. Long cable clamps to clamp together the top and bottom cables were used every 3 feet, the fascines being first compressed together; a top grillage of poles was then placed over the whole.

The actual construction of the mat did not begin until January 12, upon which day 20 feet of it was constructed on the mat barges, but as running ice was looked for the plant was not swung into position until the 2d of February, as after the ice ceased running it was not deemed safe to swing out until the Belmont ice gorge had broken. This took place on the 28th, and as no ice from this gorge made its appearance it was assumed that it had either sunk or melted, and that therefore it would be safe to swing out and begin construction of this mat. On February 8th, after 173 feet of the mat had been completed, ice suddenly made its appearance, and by evening the river was full of very heavy gorge ice. This was from the gorges in the upper Mississippi, and proved to be the heaviest run of the season. The mat was hurriedly ballasted and sunk under great difficulties, as it was almost impossible for the steamboats to get through the ice. In sinking, the pressure of the ice against the mooring barges became so great that some of the outstream-mooring cables parted, allowing the mat to swing in shore. Whether it was crowded upon the bank or "buckled" up has not as yet been ascertained, owing to the high stage of river. I believe that the latter is the case, and that the mat is practically destroyed. No steps were contemplated of saving it when the run of ice began, the [illegible] to prevent its breaking away. It was 173 feet [illegible] by 240 feet wide. [illegible] by a reference to the table giving cost of work, is very large, though a large number of the fascines still on hand are included in the cost of this mat. The fascines will probably be available the coming season for connecting mats or shore work. The cost of loading these fascines on barges was also charged to the mat.

This style of mat has many desirable features, as flexibility and the possibility of utilizing brush too small for the standard fascines being not the least important. On the other hand its extreme cost and slow progress are serious objections. Rate of progress [illegible] fascines were made directly at the bank and loaded [illegible] to the river. The cost, too, had [illegible] with this style.

River Bay mats.—[illegible] connecting mats, varying [illegible] 40 feet. All except No. [illegible] No. 7 was built [illegible] used. It was constructed [illegible] completion of this mat [illegible]

[illegible] October, upon which day [illegible] Grading was begun [illegible] About one half of [illegible] in front of river mat [illegible]

[illegible] work was done.

[illegible] but only 2 have been [illegible] On March 1, over [illegible] constructed like those [illegible] deep scallops [illegible] sailing along the bank.

All work was stopped [illegible] the suspension of the

was entirely inadequate, and to continue the double layer to the end of this mat would have caused too long a delay in starting the next mat, for of course the mooring barges would not be available until No. 7 was sunk. The top layer in this case was laid longitudinally, or up and down stream, in order to bring it nearly at right angles to the bottom or woven layer. Another innovation was that the longitudinal strand cables were doubled and each one alternately passed under and over the mat for each shift or launch. Thus each pair of cables crossed themselves about every 25 feet, the pair forming long loops of a chain within which the brush lay. The additional layer over the whole width of mat increased its cost considerably, not only in material, but also in labor. To put the extra brush on the mat from the weaving barge would have retarded the progress of weaving; therefore an extra barge of brush was placed on the outside of the mat and the brush distributed from thence. This involved a long carriage of the material and frequent shifting of the run plank over which the men walked. Wiring together of the top and bottom grillage and the fastening of the longitudinal and transverse strand cables was also rendered more difficult by the increased thickness of the mat. This form of mat required for each square 6 cords of brush and 4 cubic yards of stone above that required for the ordinary construction. This mat was sunk without any difficulty.

River Mat No. 8a.—After river mat No. 7 had been sunk there remained a gap of about 1,800 feet in the subaqueous revetment, namely, from Station No. 86.60 to 104.48, the latter being at the head of river mat No. 5. It was intended to make one continuous mat to cover this space, but by the time 830 feet had been completed, the river, which had been rising slowly for several days past, began rising more rapidly, bringing down considerable drift. In anticipation of the latter, a drift boom 600 feet long had been placed about the mooring barges and this held or deflected most of the drift from the mat. Still, as reports from above indicated the coming of considerable more water, it was decided to sink what mattress was then afloat, and this was successfully done. River mat No. 8*a* was begun on the 2d of December and sunk on the 24th. It is 830 feet long by 240 feet wide. Construction was somewhat retarded by the rapid rise and heavy run of drift. The drift boom was held by a 1-inch steel cable, but the accumulation of drift become so great that at 4 a. m. of the 22d, this cable parted, letting the boom barges swing in against the mooring barges. No damage was done, but it required the united efforts of the *Minnetonka* and a force of men on two capstans to haul the boom back into position.

River Mat No. 8b.—The plant for this mat was swung into position on January 2, by which time drift had about ceased running. Construction was carried on rapidly until the 13th, when floating ice was first noticed in the river. The run of ice increased rapidly during the day, and it was decided to sink this mat at once This was accomplished without difficulty, although the river was bank-full of heavy ice, the drift boom, which had been put out where the mat was begun, sheering off the ice nicely. This mat, when sunk, lacked 100 feet of lapping over river mat No. 5, and this small gap in the subaqueous revetment still remains, as there has been no opportunity since to close it. No damage, however, is apprehended from the small gap. No. 8*b* is 866 by 215 feet, and begins at Station 94.71, ending at Station 103.40.

River Mat No. 9.—The only work done for this mat was the driving of the abutment and the anchor piles for 1,000 feet. This was done in the earlier part of the working season, and before one revetment plant was ordered to Daniels Point. This work will all be lost. Its cost was small.

The total length of all river mats made here during the season is 8,504 linear feet, of which 3,952 feet is 200 feet wide, the balance being 240 feet or more. The total length of bank having subaqueous revetment, inclusive of the 1891 work (3,200 feet), is 11,704 feet, the excess in length of mattress made over bank covered being due to overlap. As noted under the different mats, very little difficulty was met with in construction, and none in sinking. Had there not been a partial failure in the brush supply, and serious interruptions from running ice, about 1,000 feet more of mattress might have been constructed with the available plant. It is believed that the mattresses just described are the very best ever constructed at Plum Point Reach, as particular pains were taken to compress the brush as it was being woven. The extra layer along the inner edge also improved the mats, as it gives them increased strength and thickness where most needed.

A better plan to obtain this result would be to construct a supplemental mat of 50 feet or more in width for the entire length of the main mat and sink this so as to lap over the latter 25 or 30 feet. This supplemental mat could be so laid that no connecting mats would be necessary, but the paving could start from the inshore edge of the small mat. In some cases, as for instance passing over a scallop in the bank, a small connecting mat would be necessary, but in most cases the supplemental mat could be built so that its inner edge would be above water, and the paving connected directly with it, without the additional connecting mats. These mats could be made quicker and cheaper and stronger than the ordinary connecting mats.

Connecting mats.—Of these, which were constructed and sunk as fast as the river

With the use of the "Wells" lights the capacity of the present plant is but as soon as the nights begin to get cold it is hard to keep an outside ni nor is the work satisfactory then.

The gap between Sections "D" and "E," Fletchers Bend Revetment, covered as soon as possible, as the caving is attacking the foot of Section

Ashport Revetment should be extended up about 1,000 feet to insure the the work.

The false point or salient formerly existing at the head of the Daniels P having caved off, and the bank line, which only last year was very concav become almost a straight line, the contemplated extension upstream coul undertaken with advantage.

Appended hereto is a summary of work done, together with a statem cost of the different works constructed the past season.

Respectfully submitted.

AUG. J. NOLT
Assistant E

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

Work done during the season 1892-'93.

Ashport Bend:	
Stone unloaded on bank	cubic yards
Stone loaded on bank	do
River mat made	squares
Connecting mat made	do
Pocket mat made	do
Grading	cubic yards
Paving	square yards
Clearing	acres
Dikes constructed	linear feet
Anchor piles driven	
Abutments constructed	
Brush cut and loaded	cords
Poles cut and loaded	do

Repairs to existing works.

Ashport Bend:	
Additional ballast	square yards
Fletchers Bend:	
Additional ballast	do
Paving	do
Keys Point and Elmot Bar:	
Stone unloaded on bank	cubic yards
Daniels Point:	
River mat	squares
Connecting mat	do
Grading	cubic yards
Paving	square yards
Dikes constructed	linear feet
Clearing	acres
Anchor piles driven	
Abutments constructed	

In addition to the above classified work, a large amount of work th statement of cost of work, appears as "miscellaneous work," was done. sisted in hand-dressing the slope after hydraulic grading, grubbing stumps, removing snags and drift piles, putting in dead men, sinking a the transverse cables, making model of channel works for the Columbia tion, etc. Care of and repairs to plant, though appearing as separate item be properly classified.

Material used per square of river mat:	
Brush	cord
Poles	do
Stone	cubic yard
Wire	pound
Wire strand	do
Spikes	do
Cable clamps	numbe
Staples	pound
Piling	numbe

by doing away with all sharp angles where the diaphragm joins the sides. At this juncture all cracks here hitherto originated in the original cylinders of both the Dean and Davidson pumps, while the new ones are still perfect. Both sets of pumps were originally designed for a pressure of 200 pounds per square inch, but this had been reduced to 175 pounds, which may be assumed as the safe limit.

Grading along sections No. 2 and No. 3 proceeded in advance of mattress construction, and with fair results both as to economy and perfectness of slope, but as the lower end of the latter section was reached, the outcrop of the strata changed and much sand was encountered, and in consequence but a poor slope, requiring much hand dressing, was obtained. Finally, as grading proceeded downstream, the results were so unsatisfactory that it was decided to abandon grading in advance of the mattress construction and grade only where the mats had been previously sunk.

This should be adopted as a rule, for it has been demonstrated here that no matter what the composition of the bank, a good slope can be obtained after the river mat is sunk. At section No. 1, where the composition of the bank is closely allied to that at Mud Point, grading was done after the river mat was down. At first the results were discouraging, as the lower strata of sand caved and washed badly, but upon a continuance of the work it was found that as soon as the voids under the mat were filled up by the washed-down material caving ceased and a good slope was obtained.

The progress of grading, while slow when compared with that made at other localities on the Reach, was satisfactory when the physical features of the bank operated upon are considered. The main cause of the slow progress was the number of stumps encountered on all the sections except No. 5. On section No. 3 the stumps on a piece of graded bank measuring 77 by 300 feet numbered 74, varying in diameter from 5 to 13 inches, and this was by no means the most thickly wooded portion. These stumps penetrated as much as 15 feet below the surface, and in addition there were a large number of stumps uncovered that were evidently the remains of a former cypress swamp. Section No. 5 was comparatively free of timber.

In order to expedite this class of work, two Wells lights were put in use, one for each grader, and by their aid and with double crews on each machine, night-work was done. This began on September 28, and continued until October 26, by which time grading had advanced sufficiently to warrant a discontinuance of night-work. The lights worked well, required little attention and gave ample light, with a consumption of 1¼ gallons of oil per hour. On November 29, grader No. 4 was transferred to Daniels Point, where it continued until the close of the season.

Paving.—In the early part of the season riprap was laid, as has been customary hitherto; that is, to a uniform thickness of 10 inches. This was subsequently changed by your orders to 12 inches or more for about 5 feet above the zero line, thence tapering to 6 inches at the 15-foot contour, to which latter height only all paving was to be carried.

Some soft places along the foot of slope were first covered with brush foundation mats, and all depressions of any magnitude were filled up with brush, this being always raised above the general level so as to allow for settlement and compression. There are a few places, principally at sections No. 8*a*, No. 8*b* and No. 5, where, owing to the advent of high water, the paving was not carried up quite to the 15-foot contour.

Spur dikes.—Of these there were three constructed, two in front of the Mud Point bank and one in pocket No. 2. The object of placing these spurs there was to break up the strong eddy existing there, which result has in a manner been accomplished, though the dikes are not yet completed. No. 2 requires extension outstream 50 feet and wattling for the entire length. No. 3 requires wattling and slight extension inshore, and No. 4 requires wattling. The dikes are constructed of two rows of piling 12 feet apart, strengthened at the outstream ends by an "L," the piles being placed 8 feet apart, and the whole structure well braced and turned. All piles used are cypress. Where the dikes have the low-water contour on their inshore extensions, shore mats 50 feet wide and running up to top of bank were laid. Through them the piles are driven. No. 1 has not been begun.

Test borings—This work, begun on March 22, is now in progress along the Mud Point bank. A separate report of this work will be made upon its completion.

REVETMENT AT DANIELS POINT.

River mat No. 1.—Repairs to this work, which had suffered serious damage during the previous flood, were begun on October 8, by commencing the construction of a river mat 240 feet wide, its inner edge lying along the low-water line. Considerable preliminary work, such as clearing away drift and old revetment, driving abutment, driving anchor piles, getting out mooring cables, etc., had to be done. The plant for the mat was swung into position for weaving on the 13th. When about 700 feet of its length had been completed it was found that the mat was beginning to sag badly where it had been ballasted, this sagging being due to deposits of silt accumulating upon the mat. This sagging continuing to such a degree that it was feared the mat might be strained too much, it was sunk on the 31st, after a

work the sharp salient located at the head of the 1889 work, and which caused destructive eddies below, has been cut away by the erosive action of the river, and the bank above the work is now in much better shape for upstream extension of the work than formerly.

REPAIRS TO EXISTING WORKS.

Fletchers Bend.—One of the projects for the season's work was the repair of a fault at the head of section "B" (1888 work) in this bend, but owing to nonavailability of mattress plant this could not be done. The fault has since increased in extent until now about one-half of section "B" is involved. This fault originated just below the salient formed by the juncture of the 1891 with the 1888 work. A few unimportant faults in the old work were restored, and 4,807 square yards of work reballasted, and 684 square yards of additional paving laid.

Ashport Bend.—Nineteen hundred and twenty-five square yards of the previous season's work received additional ballast.

The present condition of the work on the reach may be briefly summed up as follows, viz:

Bullerton Tow Head revetment will need extensive repairs shortly.

Osceola Bar revetment, both old and new, in good condition, except some slight faults in the old work.

Plum Point revetment damaged somewhat at lower end.

Fletchers Bend revetment, half of section "B" gone; foot of section "D" somewhat damaged; balance of new work in good condition; old work is fair.

Ashport Bend revetment in good condition.

Daniels Point revetment repairs unfinished.

No changes to be noted in the dike work.

Before concluding, I beg leave to submit the following suggestions and remarks:

The anchor piles which it has been customary to drive at 25 or 50 feet intervals along the inshore edge of the river matresses might be, without detriment to the work, omitted, and in lieu thereof piles 150 feet apart be driven for the mat to rest against during construction, so as to hold them at the proper distance out. The anchor piles were driven for the purpose of fastening the mat to them by means of strand cables yoked around the piles and fastened to the mat. We, however, found that frequently, in sinking, the cables cut into the soft wood of the piles and refuse to slip down as the mat sinks, thus holding it up. These have to be pushed down, or, if this is not possible, the strand has to be cut or the pile pulled out. Before sinking the mat, the piles are cut off close to the water surface, and if, before the connecting mats are constructed, the river should rise over their tops, much searching has to be done to locate the proper places on the mat for the holes to be cut, so that when these mats are sunk they will slip down over the piles. Should these holes, from any cause, not match with the piling, the mat will hang up.

Should it be decided to construct supplemental mats in place of the standard connecting mats, these piles would have to either be omitted or else pulled out after the main mat is sunk. Experience has shown that in sinking a matress always crowds inshore, and where the piles are driven as close as 50 feet the friction of the edge of the mat against the piling is sufficient to either hold the former up or break off the piles. In my experience there is no authenticated case of a river mattress sliding down the slope, nor do I think that if such sliding should take place the present number of cables would be sufficient to prevent it. A change in the present style of work, where the revetment will be strengthened at the line where the graded slope and the under-water slope meet, is urged as imperatively necessary, for most of the damage starts here.

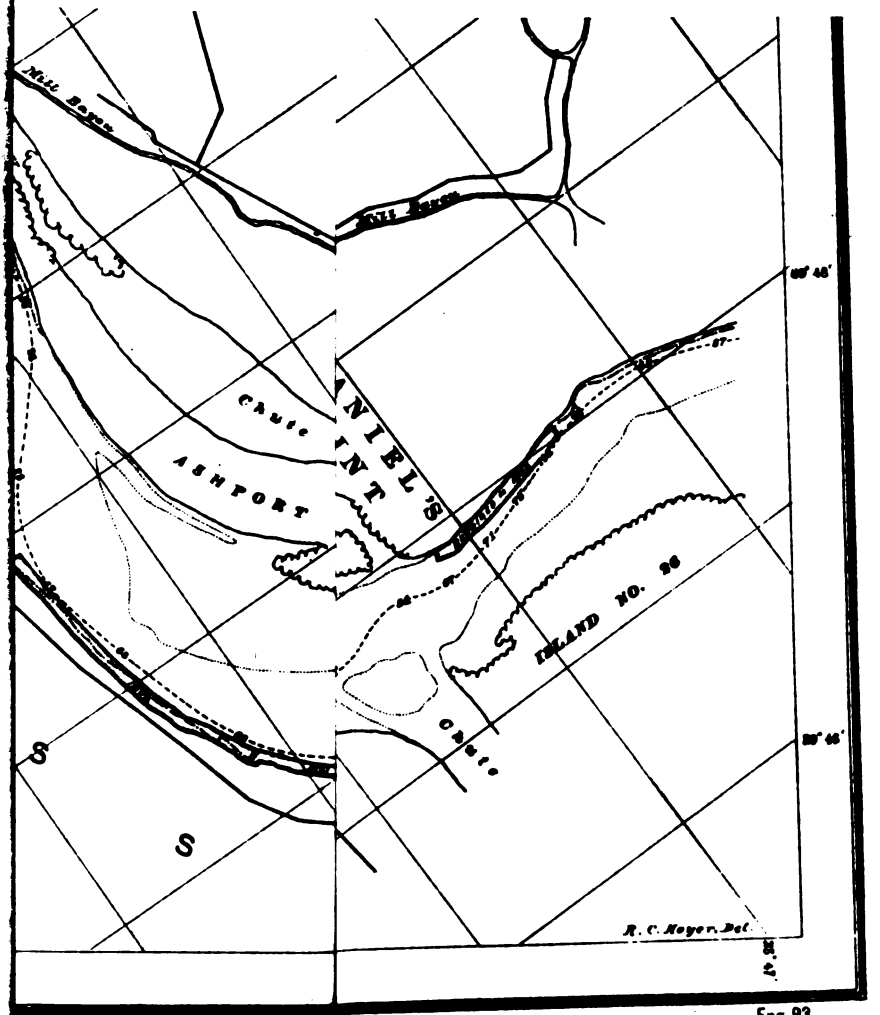
The enforcement of the eight-hour law has had its effect both upon the cost and the progress of the work. The advocates of the eight-hour law say that a man will do as much work in eight as he formerly did in ten hours. If this is the case, the average public-works laborer will be found an exception, for he now looks as eagerly for the end of the eight as he formerly did for the end of the ten-hour day. A strict observance of the law is not always compatible with an energetic and economical prosecution of the work, and the penalties threatened will tend to make the assistant in charge overcautious as to the "extraordinary-emergency" clause. It sometimes happens that some work, the postponement of which neither involves loss of life, public property, or destruction of work, might be economically completed by working a short overtime, but this is imperatively prohibited. A concise interpretation of the law by competent authority would be of value.

The question from whence to draw the brush supply is one that demands early consideration. All bars within a radius of 50 miles of the works have been pretty well denuded. There are a few places where considerable brush still stands, but it is practically inaccessible on account of the miry nature of the soil. At some places, by increasing the length of haul, a quantity might be obtained, but the bulk of the supply will have to be obtained from a long distance down the river.

Materials expended, Plum Point Reach, season 1892–'93.

ASHPORT BEND.

Names of articles.	Quantity.	Cost
Anchors, revetment ..... number..	377	
Acid, muriatic ..... pounds..	3	
Bushing ..... do....	1	
Beeswax ..... do....	31½	
Bolts, copper ..... do....	24	
Bars, capstan ..... do....	45	
Bolts, wheelbarrow ..... dozen..	6	
Brush ..... cords..	23, 712	
Burners, lantern ..... dozen..	7½	
Bolts ..... number..	472	
Brackets, lamp ..... do....	37	
Burners, lamp ..... dozen..	9½	
Bottoms, lantern ..... number..	20	
Candles ..... pounds..	30	
Coal ..... bushels..	81, 972	
Crush ..... yards..	111	
Clamps, cable ..... number..	2, 308	
Castings, stove ..... pounds..	1, 797	
Couplings ..... number..	23	
Cloth, oiled ..... rolls..	6½	
Cloth, emery ..... sheets..	48	
Chain ..... pounds..	822	
Chimneys, lamp ..... dozen..	30½	
Chrome, green ..... pounds..	1	
Clamps, hose ..... number..	71	
Charcoal ..... barrels..	4½	
Clay, fire ..... do....	1½	
Castings, brass ..... pounds..	138	
Castings, iron ..... do....	1, 078	
Cylinder, water ..... number..	1	
Drop, Black ..... pounds..	12	
Dryer, Japan ..... gallons..	1½	
Dope ..... pounds..	10	
Ducking ..... yards..	174	
Dynamite ..... pounds..	1, 000	
Exploders ..... number..	445	
Globes, lantern ..... dozen..	15½	
Gauges, glass ..... number..	5	
Glass ..... panes..	158	
Grates, stove ..... number..	8	
Gauge cocks ..... do....	3	
Guards, valve ..... do....	6	
Hemp, Italian ..... pounds..	7½	
Handles, ax ..... number..	112	
Handles, maul ..... do....	107	
Hose ..... feet...	300	
Handles, file ..... number..	1	
Hasps ..... do....	16	
Hinges ..... pairs..	25	
Iron ..... pounds..	1, 182	
Labor		
Lye ..... cases..	17½	
Locks, pad ..... number..	23	
Leather, sole ..... pounds..	38½	
Lead, white ..... do....	1, 106	
Lead, sheet ..... do....	2½	
Nuts, blank ..... number..	6	
Nails ..... pounds..	1, 407	
Lumber ..... feet..	16, 373	
Matches ..... gross..	18	
Marlin ..... pounds..	9, 18	
Metal, antifriction ..... do....	10	
Oil, signal ..... gallons..	649	
Oil, cylinder ..... do....	206	
Oil, headlight ..... do....	2, 123	
Oakum ..... pounds..	625	
Oil, linseed ..... gallons..	86	
Oil, black ..... do....	162	
Oil, lard ..... do....	105½	
Pipe ..... lengths..	8	
Piling ..... number..	223	
Piling ..... feet..	5, 155	
Putty ..... pounds..	34	
Paint, Benzole ..... gallons..	5	
Poles ..... cords..	2, 861½	
Packing, asbestos ..... pounds..	44½	
Packing, hemp ..... do....	76½	
Prussian blue ..... do....	2	
Packing, square ..... do....	5½	


Mill Bayou
Mill Bayou
Chute
Ashport
NIEL'S
INTE
ISLAND NO. 96
Chute
S
S
R. C. Meyer, Del.

Eng 93

aving, per square yard:		
Stone	cubic yards..	.385
Spalls	do....	.113
aving, per linear foot:		
Stone	do....	1.709
Spalls	do....	.501
onnecting mat, per square:		
Brush	cords..	1.117
Poles	do....	.136
Stone	cubic yards..	2.228
Wire	pounds..	6.716
Wire strand	do....	2.024
Spikes	do....	.24
Cable clamps	number..	.0078
Staples	pounds..	.0012
ocket or floor mats, per square:		
Brush	cords..	.83
Poles	do....	.145
Stone	cubic yards..	1.55
Wire	pounds..	7.44
Wire strand	do....	2.00
Spikes	do....	.206
Clamps	number..	.065
Staples	pounds..	.025

Detailed cost of works, Plum Point Reach, 1892–'93.

The following shows the cost of work in detail and also the cost per unit:

hport Bend:		
River mats, 18,996 squares, at $4.276 per square		$81,228.20
Connecting mats, 4,242 squares, at $8.17 per square		34,656.07
Pocket mats, 1,199 squares, at $5.90 per square		7,079.69
Paving, 25,508 square yards, at $0.9112 per square yard		24,921.61
Grading, 304,715 cubic yards, at $0.038 per cubic yard		11,586.87
Clearing, 16.5 acres, at $42.56 per acre		753.04
Spur dikes		1,230.48
Repairs to and preservation of existing works		1,906.17
Towing*	$7,793.21	
Miscellaneous*	3,388.71	
Handling stone†	12,797.47	
Care of quarters		720.89
Care of plant		7,543.47
Repairs to plant		2,919.81
Total cost		174,546.30

Length of revetment (1892–'93), 8,350 feet. Care of quarters, care of plant, repair o plant, cost per lineal foot, exclusive of dikes, and repair to old work, $19,222.

letchers Bend:		
Repair to and preservation of existing work		$2,632.66
Daniels Point:		
River mat, 6,551 squares, at $5.090 per square		33,345.46
Connecting mat, 1,437 squares, at $7.8112 per square		11,234.86
Grading, 33,060 cubic yards, at $0.06295 per cubic yard		2,081.53
Paving, 1,412 square yards, at $1.995 per square yard		2,816.81
Clearing		468.98
Spur dikes‡		1,037.25
Towing*	$3,681.04	
Miscellaneous*	1,037.94	
Care of quarters		236.08
Repairs to plant		345.06
Care of plant		2,450.49
Total cost		54,016.52

Length of revetment, 2,761 feet. Cost per linear foot, exclusive of dikes, $18.322. Revetment not complete.

*Incorporated in "cost of work."

†Cost per yard, $0.1692; includes unloading on bank and reloading on barges. This being added to quarry price and cost of towing, gave the cost per cubic yard ($1.46), and is included in "cost of work."

‡Not completed.

Materials expended, Plum Point Reach, season 1892–'93.

ASHPORT BEND.

Names of articles.	Quantity.	Cost.
Anchors, revetment ..... number..	377	$55.07
Acid, muriatic ..... pounds..	3	.60
Bushing ..... do....	1	.60
Beeswax ..... do....	31½	8.72
Bolts, copper ..... do....	24	15.60
Bars, capstan ..... do....	45	33.75
Bolts, wheelbarrow ..... dozen..	6	1.80
Brush ..... cords..	23, 712	24, 024.36
Burners, lantern ..... dozen..	7½	2.73
Bolts ..... number..	472	8.10
Brackets, lamp ..... do....	37	2.67
Burners, lamp ..... dozen..	9½	6.26
Bottoms, lantern ..... number..	20	5.75
Candles ..... pounds..	30	.60
Coal ..... bushels..	81, 972	7, 754.60
Crash ..... yards..	111	9.94
Clamps, cable ..... number..	2, 308	75.20
Castings, stove ..... pounds..	1, 797	60.42
Couplings ..... number..	23	5.45
Cloth, oiled ..... rolls..	6½	14.62
Cloth, emery ..... sheets..	48	1.80
Chain ..... pounds..	822	31.24
Chimneys, lamp ..... dozen..	30½	19.45
Chrome, green ..... pounds..	1	.11
Clamps, hose ..... number..	71	4.97
Charcoal ..... barrels..	4½	3.75
Clay, fire ..... do....	1½	3.00
Castings, brass ..... pounds..	138	47.03
Castings, iron ..... do....	1, 078	28.05
Cylinder, water ..... number..	1	425.00
Drop, Black ..... pounds..	12	1.32
Dryer, Japan ..... gallons..	1½	1.20
Dope ..... pounds..	10	.15
Ducking ..... yards..	174	14.73
Dynamite ..... pounds..	1, 000	215.00
Exploders ..... number..	445	20.53
Globes, lantern ..... dozen..	15½	28.21
Gauges, glass ..... number..	5	.60
Glass ..... panes..	158	14.67
Grates, stove ..... number..	8	9.50
Gauge cocks ..... do....	3	1.20
Guards, valve ..... do....	6	2.58
Hemp, Italian ..... pounds..	7½	1.46
Handles, ax ..... number..	112	12.92
Handles, maul ..... do....	107	8.02
Hose ..... feet..	300	341.36
Handles, file ..... number..	1	.60
Hasps ..... do....	16	.47
Hinges ..... pairs..	25	3.00
Iron ..... pounds..	1, 182	29.29
Labor	.....	53, 314.90
Lye ..... cases..	17½	31.78
Locks, pad ..... number..	23	6.44
Leather, sole ..... pounds..	38¾	12.26
Lead, white ..... do....	1, 106	75.26
Lead, sheet ..... do....	2½	.20
Nuts, blank ..... number..	6	.15
Nails ..... pounds..	1, 407	29.23
Lumber ..... feet..	16, 373	216.54
Matches ..... gross..	18	22.24
Marlin ..... pounds..	9, 18	85.85
Metal, antifriction ..... do....	10	2.00
Oil, signal ..... gallons..	649	181.79
Oil, cylinder ..... do....	206	76.90
Oil, headlight ..... do....	2, 123	203.22
Oakum ..... pounds..	625	43.54
Oil, linseed ..... gallons..	86	34.20
Oil, black ..... do....	162	8.54
Oil, lard ..... do....	105½	62.92
Pipe ..... lengths..	8	25.88
Piling ..... number..	223	267.60
Piling ..... feet..	5, 155	219.06
Putty ..... pounds..	34	.77
Paint, Benzole ..... gallons..	5	3.00
Poles ..... cords..	2, 861½	4, 207.10
Packing, asbestos ..... pounds..	44½	18.90
Packing, hemp ..... do....	76½	16.60
Prussian blue ..... do....	2	.48
Packing, square ..... do....	5½	3.97

Table of cost of repairs to plant at Amelia, Ark., from May 1, 1892, to April 1, 1893.

Steamers:	
Titan	$1,443.49
Graham	2,806.88
Kirns	4,022.43
Itasca	266.18
Abbot	62.59
Hydraulic grader No.—	
2	2,719.48
4	4,121.27
40	167.91
Pile-drivers No.—	
20	198.66
21	425.07
25	1.26
27	100.11
57	140.57
59	252.65
61	36.39
Machine boat No.—	
1	3,071.39
2	3,645.17
Quarter boat No.—	
30	109.28
29 (headquarters)	310.70
26 (material store boat)	418.84
12	326.01
10 (bake shop)	282.83
28	31.17
6	3.49
25	35.86
11	16.70
13	18.70
27	14.01
District barge No.—	
55	$101.05
66	88.98
74	82.57
76	126.52
91	43.96
152	1.78
Mattress barge No.—	
1	52.41
2	48.52
3	219.78
4	258.22
6 (old)	265.23
Gunwale barge No.—	
161 (cut down)	988.62
193	43.86
180 (mooring)	283.18
189 (mooring)	64.38
Two (coal barge) mooring barges	375.43
Frame barge No.—	
223	213.44
221	180.10
8 model barges (Maj. Miller)	211.68
Skiffs and flats	245.39
Floating dock	37.33
Warehouse A	512.74
General repairs	1,682.83
Total cost	31,207.12

Abstract of proposals for furnishing brush and poles for use at Hopefield Bend, Arkansas, received in response to advertisement dated August 22, 1892, and opened September 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

Name and address of bidder.	12,000 cords willow brush.	2,000 cords willow poles.
	Per cord.	*Per cord*
Hunter & Frey, Memphis, Tenn.*	$0.95	$1.50

*Accepted.

Abstract of proposals for furnishing stone for use at Hopefield Bend, Arkansas, received in response to advertisement dated August 22, 1892, and opened September 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

Name and address of bidder.	10,000 cubic yards on bank at Hopefield.	10,000 cubic yards on barges at West Memphis.
	Per cubic yd.	*Per cubic yd.*
Edward Hely, West Plains, Mo.*	$1.85	$1.70
Henry & Co., Birmingham, Ala	1.94	1.97
J. W. Alley, Memphis, Tenn		1.75

*Accepted.

Materials expended, Plum Point Reach, season 1892–'93—Continued.

DANIELS POINT—Continued.

Names of articles.	Quantity.	Cost.
Clamps, cable ..... number..	547	$29.94
Clamps, cable, fascine ..... do....	3,065	349.41
Cloth, emery ..... sheets..	49	1.19
Chrome, yellow ..... pounds .	1	.23
Castings, brass ..... do....	15	10.00
Castings, iron ..... do....	180	3.60
Dope ..... do....	10	.15
Globes, lantern ..... dozen..	3	2.70
Glass ..... panes..	34	5.62
Grates, stove ..... number..	3	3.00
Handles, ax ..... do....	6	.66
Handles, maul ..... do....	8	.72
Hasps ..... do....	5	.13
Iron ..... pounds..	156	4.31
Labor		19,048.65
Lye ..... cases..	5	3.31
Leather, sole ..... pounds..	9	2.92
Lead, white ..... do....	25	1.75
Nails ..... do....	28	.71
Lumber ..... feet..	654	13.08
Matches ..... gross..	7⅛	8.11
Oil, signal ..... gallons..	76	20.46
Oil, cylinder ..... do....	57	19.95
Oil, headlight ..... do....	591	55.76
Piling ..... number..	66	79.20
Piling ..... feet..	5,067	215.21
Putty ..... pounds..	1	.03
Poles ..... cords..	880	1,305.28
Packing, asbestos ..... pounds..	2	.46
Prussian blue ..... do....	1	.24
Packing, hemp ..... do....	3½	.24
Packing, square ..... do....	2½	1.34
Plumbago ..... do....	½	.08
Pipe, gas ..... feet..	8½	1.02
Packing, sheet ..... pounds..	18	3.52
Pipe, stove ..... joints..	12	3.96
Packing, round ..... pounds..	5½	1.29
Packing, Selden's ..... do....	3½	1.20
Plugs ..... number..	1	.50
Rope, manilla ..... do....	8,310	612.73
Rope, wire ..... pounds..	1,013	69.05
Rope, cotton ..... do....	2	.45
Shackles ..... number..	4	7.72
Soap, laundry ..... box..	23⅓	45.48
Soap, toilet ..... bars..	49	2.07
Staples ..... pounds..	142	4.90
Straw ..... bales..	23	14.70
Stationery		5.80
Spikes ..... pounds..	402	128.54
Steel ..... do....	10	.99
Strand wire ..... do....	24,576	1,006.90
Screws ..... dozen..	1	.25
Subsistence		5,244.99
Stone ..... yards..	8,377.82	12,231.62
Tin, sheets ..... sheets..	46½	12.75
Tacks ..... pounds..	2	.36
Valves, globe ..... number..	1	.75
Waste ..... pounds..	44	3.32
Wicks, lamp ..... dozen..	21½	2.48
Wheels, barrow ..... do....	1	10.65
Wire, galvanized ..... pounds..	71,665	1,965.92
Wood ..... cords..	27	81.15
Total cost	.....	54,016.52

TOWING NEW MADRID REACH.

Bluing ..... bottles..	1	$0.25
Strawboard ..... sheets..	3	.09
Beeswax ..... pounds..	4	1.16
Bolts ..... number..	18	.36
Burners, lamp ..... dozen..	1½	.95
Coal ..... bushels..	6,605	779.39
Cloth, emery ..... sheets..	6	.12
Candles ..... pounds..	5	.40
Chimneys, lamp ..... dozen..	3	1.75
Chrome green ..... pounds..	4	.49

Materials expended, Plum Point Reach, season 1893-'93—Continued.

TOWING NEW MADRID REACH—Continued.

Names of articles.	Quantity.	Cost.
Drop black ..... pounds..	11	$1.21
Dryer, Japan ..... gallons..	1	.64
Globes, lantern ..... number..	17	1.53
Glass ..... panes..	3	.12
Iron ..... pounds..	48	.96
Labor		743.84
Matches ..... gross..	1	.65
Oil, signal ..... gallons..	15	4.50
Oil, headlight ..... do....	123	11.32
Oakum ..... pounds..	100	6.74
Packing, asbestos ..... do....	3	1.29
Soap, toilet ..... bars..	12	.55
Starch ..... pounds..	5	.25
Subsistence		121.20
Waste ..... pounds..	34	2.62
Wicks, lamp ..... dozen..	4	.18
Wood ..... cords..	6	7.50
Total cost		1,690.66

FLETCHERS BEND.

Labor		$668.47
Stone ..... cubic yards..	1,201	1,753.46
Subsistence		33.41
Total cost		2,455.34

LEVEES, WHITE RIVER FRONT.

Labor		$294.29
Subsistence		61.66
Coal ..... bushels..	1,691	150.16
Total cost		506.11

APPENDIX 4 C.

REPORT OF ASSISTANT ENGINEER C. W. STURTEVANT ON REPAIRS TO PLANT.

UNITED STATES ENGINEER OFFICE,
Amelia, Ark., April 18, 1893.

CAPTAIN: I have the honor to submit the following report upon repairs to plant at Amelia, Ark., from May 1, 1892, to April 1, 1893.

Steamboats.—Steamer *Titan*, during the months of October and November, 1892, had two pairs of vertical posts set along the sides of both sets of cylinder timbers with the top of each pair framed to its opposite pair on the other side of the boat to prevent the side or weaving motion of the cylinder timbers. New stanchions have been placed under the cylinder timbers and diagonal braces so placed as to prevent the fore and aft movement of the timbers. New stacks 2 feet in diameter were put on the boat in place of the old ones, which were rusted out and were 3 feet in diameter. The decrease in the size of stacks improved the draft of the furnace. Other minor repairs have been made that are usually necessary to a towboat in commission.

Steamer *Graham* was docked in June, 1892, and received a new set of starboard cylinder timbers, a new wheel, hull repaired and caulked, cabin repaired and painted, forward mud drum on boilers moved back, grate surface lengthened 12 inches, and cylinders counterbored.

Steamer *Kirns* was docked in July, 1892, and had the following parts renewed, as well as other minor repairs: New cylinder timbers complete, hog-chain braces, transom, stem, and rudders.

Steamer *Itasca* has received only such minor repairs as have been necessary to keep this boat in working condition.

Steamer *Abbot* has had two knees built on bow for towing and such repairs as were necessary to keep the boat in commission.

Abstract of proposals for levee work, received in response to advertisement dated December 30, 1892, and opened January 24, 1893, by Capt. S. W. Roessler, Corps of Engineers.

[Price per cubic yard.]

No.	Name and address of bidder.	Upper Yazoo levee district.					Lower St. Francis levee district.			
		Sections 60, 62, and 63.	Station 1340 to 1420.	Station 1420 to 1493, and station 1531 to 1544.	Station 1630 to 1749.	Station 1493 to 1531.	Station "0" to 158.	Station 158 to 317.	Station 317 to 422.	Station 422 to 475.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Garbish & O'Neil, Memphis, Tenn	15 7/10	.....	.....	.....	.....	.....	.....	.....	.....
2	C. A. Winter, Greenville, Miss	.....	20 40/100	22 50/100	19	26 50/100	.....	.....	.....	.....
3	Timothy Sullivan, Memphis, Tenn	15 75/100	*15 00/100	21	21½	36½	11 97/100	11 45/100	12 45/100	15 [illegible]
4	W. A. Shippey, Memphis, Tenn	15½	.....	.....	.....	.....	.....	11 75/100	.....	.....
5	Edward B. Mantell, Memphis, Tenn	18½	.....	.....	.....	.....	.....	.....	.....	.....
6	McLaughlin Bros., Memphis, Tenn	16½	17	†16 75/100	18	22	12 45/100	11 70/100	11 95/100	18 [illegible]
7	Haman, McFadden & Cassidy, Baton Rouge, La	.....	.....	.....	.....	34	12 7/10	13 7/10	14 1/10	22
8	A. J. Robinson, Memphis, Tenn	18½	.....	.....	.....	.....	.....	.....	.....	.....
9	John C. Hodge, Memphis, Tenn	.....	.....	.....	.....	.....	13½	11½	11½	16½
10	Hogan & Robertson, Cairo, Ill	.....	.....	.....	.....	.....	14½	14	14	12
11	Conner & Lester, Benoit, Miss	16½	16½	17	17	†19	15	14½	14½	15
12	Epply & Martin, Bolivar, Miss	.....	.....	.....	.....	.....	12 75/100	11 30/100	12 55/100	20
13	R. T. Martin, Bolivar, Miss	15 45/100	18 70/100	.....	15	26	.....	.....	.....	.....
14	Hunter & Frey, Memphis, Tenn	.....	.....	.....	.....	.....	10½	9½	12½	18
15	Harvey & McGuire, Greenville, Miss	.....	16	19	15	20	14	13½	14½	16½
16	Hartuett, O'Brien, Donovan & Daily, Memphis, Tenn	.....	18½	.....	16 7/10	.....	11 80/100	10 80/100	11 40/100	18 [illegible]
17	Thomas J. Bogue, Beulah, Miss	.....	.....	.....	.....	.....	11 75/100	10 75/100	11 55/100	22½
18	Earnest Hyner, Greenville, Miss	.....	.....	.....	.....	.....	19 80/100	13 80/100	14 80/100	20 [illegible]
19	T. S. Aderhold, Friars Point, Miss	*14 40/100	19	19½	*13 40/100	33	.....	.....	.....	.....
20	M. N. Hewey, Birmingham, Ala	.....	.....	.....	.....	25	13 97/100	11 80/100	12 55/100	19 [illegible]
21	Green Clay & Son, Mexico, Mo	.....	.....	.....	.....	.....	17	12½	12½	24
22	T. C. Ferguson, Glendale, Miss	15 75/100, 16 85/100	17 80/100	18 95/100	17 85/100	.....	17 40/100	15 40/100	.....	.....
23	Arnold, De Garis & Co., Memphis, Tenn	17½	18	20	20½	26	14	13½	14½	15
24	W. L. Withers & Co., Gladstone, Miss	.....	.....	.....	.....	.....	15½	12	12½	27
25	Hebron & Hebron, Vicksburg, Miss	.....	.....	23 95/100	19 95/100	24 80/100	14½	11½	11½	19½
26	J. S. McTighe & Co., Memphis, Tenn	21	23	24½	24½	29	10½	10½	10½	11½
27	Scott & Russell, Memphis, Tenn	.....	.....	.....	.....	.....	13	12	12	17 [illegible]
28	Jeffries & Dameron, Memphis, Tenn	16	17	18½	15	21	12½	11½	13	17
29	Hayes & Hayes, Welchton, La	.....	.....	.....	.....	.....	14½	12 70/100	15	18
30	A. B. Carter, Memphis, Tenn	.....	.....	.....	.....	.....	18½	13½	16½	.....
31	Sullivan & Johnson, Memphis, Tenn	24	21	22	22½	19½	14	12 40/100	12 85/100	15½
32	Jno. Scott & Son, St. Louis, Mo	.....	.....	.....	.....	.....	12 85/100	11 85/100	12 55/100	21 [illegible]
33	J. W. Eldridge, Hillhouse, Miss	.....	17 75/100	17 75/100	.....	.....	.....	.....	.....	.....
34	Meredith & Speers, Memphis, Tenn	.....	.....	.....	.....	.....	16	13½	15½	19½

*Accepted (lowest bid.) †Bidder failed to enter into contract. This piece of work was readvertised

Table of cost of repairs to plant at Amelia, Ark., from May 1, 1892, to April 1, 1893.

Steamers:	
Titan	$1,443.49
Graham	2,806.88
Kirns	4,022.43
Itasca	266.18
Abbot	62.59
Hydraulic grader No.—	
2	2,719.48
4	4,121.27
40	167.91
Pile-drivers No.—	
20	198.66
21	425.07
25	1.26
27	100.11
57	140.57
59	252.65
61	36.39
Machine boat No.—	
1	3,071.39
2	3,645.17
Quarter boat No.—	
30	109.28
29 (headquarters)	310.70
26 (material store boat)	418.84
12	326.04
10 (bake shop)	282.83
28	31.17
6	3.49
25	35.86
11	16.70
13	18.70
27	14.01
District barge No.—	
55	$101.05
66	88.98
74	82.57
76	126.52
91	43.96
152	1.78
Mattress barge No.—	
1	52.41
2	48.52
3	219.78
4	258.22
6 (old)	265.23
Gunwale barge No.—	
161 (cut down)	988.62
193	43.86
180 (mooring)	283.18
189 (mooring)	64.38
Two (coal barge) mooring barges	375.43
Frame barge No.—	
223	213.44
224	180.10
8 model barges (Maj. Miller)	211.68
Skiffs and flats	245.39
Floating dock	37.33
Warehouse A	542.74
General repairs	1,682.83
Total cost	31,207.12

Abstract of proposals for furnishing brush and poles for use at Hopefield Bend, Arkansas, received in response to advertisement dated August 22, 1892, and opened September 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	12,000 cords willow brush.	2,000 cords willow poles.
		Per cord.	*Per cord*
1	Hunter & Frey, Memphis, Tenn.*	$0.95	$1.50

* Accepted.

Abstract of proposals for furnishing stone for use at Hopefield Bend, Arkansas, received in response to advertisement dated August 22, 1892, and opened September 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	10,000 cubic yards on bank at Hopefield.	10,000 cubic yards on barges at West Memphis.
		Per cubic yd.	*Per cubic yd.*
1	Edward Hely, West Plains, Mo.*	$1.85	$1.70
2	Henry & Co., Birmingham, Ala.	1.94	1.97
3	J. W. Alley, Memphis, Tenn.		1.75

* Accepted.

Abstract of proposals for levee work in Upper and Lower White River levee districts received in response to advertisement dated September 28, 1892, and opened October 10, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Upper—	Lower.			
		Station 1040 to 1120	Station 989 to 1032.	Station 1032 to 1107.	Station 903 to 780.	Station 780 to 677.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*
1	J. H. Cary, Memphis, Tenn		$0.20	*$0.16½		
2	Sneed & Blue, Memphis, Tenn				$0.17½	
3	R. H. Beith, Beiths Landing, Ark					$0.17½
4	Scott & Russell, Memphis, Tenn		.21	.21	*.15½	*.15½
5	C. F. DeGaris & Co., Memphis, Tenn	$0.2758	*.19½	.16½	.16½	.16½
6	J. S. McTighe & Co., Memphis, Tenn	*.27	.23	.22	.24	.24
7	Sullivan, Johnson & McLaughlin, Memphis, Tenn	.37½	.21½	.21	.18½	.19½
8	Jeffries & Dameron, Memphis, Tenn	.27				
9	Hartnett & O'Brien, Memphis, Tenn			.17$\frac{85}{100}$	.17½	.17½

*Lowest bid—accepted.

Abstract of proposals for levee work in Upper Yazoo levee district received in response to advertisement dated September 28, 1892, and opened October 8, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Station 4346 to station 4417.	Station 4417 to station 4488.	Station 4488 to Ward Lake Levee.	Station 1159 to station 1202.	New Pushmataha Loop.	
						Upper half.	Lower half.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*
1	Harvey & McGuire, Greenville, Miss	$0.19½	$0.18½	$0.18½	$0.22	*$0.18	$0.19
2	Scott & Russell, Memphis, Tenn	.19½	.20½	.24		.21	.21
3	J. S. McTighe & Co., Memphis, Tenn	.21	.26	.25	.30	.29	.32
4	A. McDonald, Memphis, Tenn	*.18⅜					
5	DeGaris & Arnold, Memphis, Tenn	.18¾	*.18¼	.19¾	.27	.24	.26½
6	P. F. Lamb, Memphis, Tenn				*.20		*.16½
7	J. H. Cary, Memphis, Tenn	.22	.33	.27			
8	Hartnett & O'Brien, Memphis, Tenn					.20	.21
9	Sullivan, Johnson & McLaughlin, Memphis, Tenn	.27	.27	.30	.40	.22½	.24½
10	Jeffries & Dameron, Memphis, Tenn	.18¾	.23	.21	.27	.19	.20
11	Hugh Morgan, Memphis, Tenn			*.17½			
12	E. B. Mantell, Memphis, Tenn	.20.5					
13	T. S. Aderholdt, Friars Point, Miss	.21½	.22	.23	.43		

*Lowest bid—accepted.

Abstract of proposals for levee work in Lower White River levee district received in response to advertisement dated October 17, 1892, and opened October 24, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From Station 677 southward to vicinity of Beasley's.	
		To be finished March 1, 1893,	To be finished January 1, 1894.
		Per cu. yard.	*Per cu. yard.*
1	Scott & Russell, Memphis, Tenn		$0.21
2	Hartnett & O'Brien, Memphis, Tenn		*.15
3	Vance & Franklin, Garvey, Ark	$0.20	.17
4	John R. Greer, Memphis, Tenn		.21½
5	Sullivan, Johnson & McLaughlin, Memphis, Tenn	.19½	.17½
6	C. F. DeGaris & Co., Memphis, Tenn	.21½	.17½
7	Timothy Sullivan, Memphis, Tenn		.17½

*Accepted.

Abstract of proposals for removal of Nonconnah Rock, Mississippi River, received in response to advertisement dated November 1, 1892, and opened December 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard.
1	Johnson & Townsend, Somers Point, N. J.	$4.95
2	Ethan A. Burress, New Orleans, La.	2.90
3	H. S. Brown, Quincy, Ill.	2.75
4	J. H. Cary, Memphis, Tenn.*	2.65

*Accepted.

Abstract of proposals for furnishing stone for use on Plum Point Reach, received in response to advertisement dated March 6, 1893, and opened March 16, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Names and address of bidder.	Kind of stone.	10,000 cubic yards coarse riprap.	10,000 cubic yards small riprap.	5,000 cubic yards spalls.
			Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*
1	J.W. Worthington & Co., Birmingham, Ala	Limestone	$3.50	$3.50	$3.50
		Sandstone	3.50	3.50	3.50
2	Johnson Barrett, Frankfort, Ky.	Limestone			
		Sandstone	1.64	1.64	1.49
3	Frederick Hartwig, Cincinnati, Ohio*	Limestone	1.59	1.69	1.30
		Sandstone	1.54	1.64	1.20
4	John J. Shipman, Shawneetown, Ill.	Limestone	1.85	1.80	1.75
		Sandstone	1.90	1.85	1.75

*Accepted.

Abstract of proposals for levee work, Upper and Lower White River levee districts, received in response to advertisement dated December 24, 1892, and opened January 19, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Upper White River levee district.		Lower White River levee district.	
		From Station 1120 to 1160.	From Station 1160 to 1200.	From Station 1110 to 1205.	From Station 1205 to 1295.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*
1	McLaughlin Bros., Memphis, Tenn.	$0.30½	$0.24 98/100	$0.20½	$0.26½
2	James M. Sullivan, Memphis, Tenn.	.26½	.26½	.20	.20½
3	Thomas C. Ferguson, Glendale, Miss.			.21½	
4	Arnold DeGaris & Co., Memphis, Tenn.	.23⅜	*.21⅞	.14⅞	*.18⅜
5	Jeffries & Dameron, Memphis, Tenn.	.23	.24	.18½	.22
6	Hugh Morgan, Memphis, Tenn.			.17⅜	.21⅞
7	Fruin-Bambrick Construction Co., St. Louis, Mo	.24 24/100	.24 96/100	.23	.30
8	J. B. Lewis, Luna, Ark.	.24¼	.23½	*.14½	.19½
9	William R. Harvey, Greenville, Miss.			.16	.20
10	T. J. Bogue, Beulah, Miss.		.24 75/100	.24 34/100	
11	W. L. Killebrew, Greenville, Miss.			.16 5/10	.21 2/10
12	J. S. McTighe & Co., Memphis, Tenn.	.28½	.28½	.16 75/100	.21 99/100
13	Patrick F. Lamb, Memphis, Tenn.			.16⅞	.21
14	James H. Cary, Memphis, Tenn.	*.22	.22	.17	.20½

*Accepted (lowest bid).

Abstract of proposals for constructing 30 decked barges, received in response to advertisement dated January 18, 1893, and opened February 1, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Price per barge for 10 barges.	Remarks.
1	Weigel Bros., & Co., Elizabeth, Penn.	$3,100	Accepted for 10 barges.
2	David S. Barmore, Madison, Ind.	3,170	Accepted for 9 barges.
3	Ed. J. Howard, Jeffersonville, Ind.	3,192	
4	S. M. Flesher, Lavanna, Ohio.	2,800	Accepted for 10 barges.
5	Thos. P. Morse, South St. Louis, Mo.	3,500	

APPENDIX 5.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS, UPON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1893.

GENERAL: I have the honor to submit the following report of operations in the third district, improving the Mississippi River, for the year ending May 31, 1893:

This district extends from the mouth of White River to Warrenton, Miss., a distance of 220 miles. In its improvement work has been undertaken at Lake Bolivar Front, Ashbrook Neck, Greenville, Lake Providence Reach, Delta Point, and Vicksburg Harbor, and levees have been constructed and enlarged in the Lower Yazoo, Upper Tensas, and Middle Tensas Levee districts.

Lake Bolivar Front.—The object of this improvement has been to stop a caving of the bank, which was threatening the destruction of a large levee across the end of Lake Bolivar; 4,400 linear feet of mattress was constructed in 1888-'89, covering 4,250 feet of bank.

Additional description of this work will be found in the Report of the Chief of Engineers for 1889, p. 2704. The revetment consisted of a subaqueous mat 250 feet wide for a distance of 3,300 feet from the upper end, the lower 1,100 feet being covered by a mat of a width of 180 feet, reported as being built on a rapidly rising river.

The upper bank was graded to a slope of 1 on 3 and covered with a brush revetment loaded with stone. The following amounts of material were used in its construction:

Material.	Total.	Per square of 100 feet.	Per running foot.
Brush.....cords..	9,639	.41	2.20
Poles.....do....	1,669	.07	.38
Stone.....cubic yards..	10,154	.....	2.29
Wire.....pounds..	129,310	5.5	29.4
Cable.....do....	25,025	2.4	5.88
Iron rods.....do....	51,924	5.04	12.2

In November, 1889, this work was repaired at the landing by sinking a foot mat 255 by 65 feet, and revetting a space 250 feet wide above. During the past season 2,234 cubic yards of stone have been placed on the upper bank revetment from a stage of about 5 feet above extreme low water to a two-thirds stage at points where the brush showed a tendency to decay.

Soundings were taken over this revetment in December, 1892, on ranges about 100 feet apart, and have been compared with a set taken in June, 1889. These soundings show a general fill over the mats 250 feet wide, while the 180-foot mat has sunk from 5 to 15 feet at its outer edge. On a number of ranges the mat appears to have rotated about an axis situated approximately at the low-water surface, and has assumed a steeper slope, although on three of the sections this action is not manifest. To 2+38 the mat could be detected by the leadsman. Below this range it appears to have been destroyed a distance of about 400 feet. An examination of the sections of 1889 shows that while the outer edge of this mat was in water from 50 to 60 feet deep, thalweg depths of from 90 to 100 feet obtained. In 1892, on ranges from 27+10 to 0+75 the thalweg has moved in closer to the mat.

This revetment has accomplished the purpose for which it has been constructed. The caving has ceased at the end of the lake. To prevent the tendency to undermine observed along the mat 180 feet wide it is proposed during the coming season to construct a mat over it of sufficient width to extend to the line of deepest water.

Ashbrook Neck.—The object of the work at this locality has been to prevent the caving of the bank which was threatening to form a cut-off across the Neck, with its resultant disturbance of the regimen of the river.

The project adopted for this improvement in 1890 consisted of a continuous revetment of the upper side of the Neck at its narrowest part for a distance of 8,000 feet, the mats to extend to the deepest water. During the season 1890-91, 2,820 linear feet of this revetment was constructed. Due to the high stage of the river at which the work was done, the subaqueous mat was given a width of 300 feet, with the exception of the lower 500 feet, which was constructed upon a rapidly rising river, and given a width of but 180 feet. The bank was graded to a slope of 1 to 3, and covered with a brush and stone revetment to a two-thirds stage.

Abstract of proposals for levee work received in response to advertisement dated December 20, 1892, etc.—Continued.

No.	Name and address of bidder.	Upper Yazoo levee district.					Lower St. Francis levee district.			
		Sections 60, 62, and 63.	Station 1340 to 1420.	Station 1420 to 1493, and station 1531 to 1544.	Station 1630 to 1749.	Station 1493 to 1531.	Station "0" to 158.	Station 158 to 317.	Station 317 to 422.	Station 422 to 475.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
35	Edwin R. Shelton, Memphis, Tenn	.....	.....	.....	.....	.....	.....	13	.....	.....
36	P. F. Lamb, Memphis, Tenn	.....	19½	18½	17 88/100	30	12 99/100	12½	13	16½
37	Chas. E. Sessions, Friars Point, Miss	16 45/100	18 45/100	20 90/100	17	24 74/100	12 99/100	12 99/100	.....	.....
38	Hugh Morgan, Memphis, Tenn	16½	.....	.....	.....	.....	.....	.....	.....	.....
39	M. McTighe, Memphis, Tenn	18	.....	.....	.....	.....	15	.....	.....	.....
40	J. E. O'Hearn, Wilmington, N. C	.....	21½	21½	17 13/16	20 5/16	12 7/16	11 7/16	11 5/16	21
41	James H. Cary, Memphis, Tenn	20	21	21	19	22½	16	13 5/16	15	18

NOTE.—Work in Lower St. Francis levee district withdrawn.

Abstract of proposals for levee work in Upper Yazoo levee district, received in response to advertisement dated February 8, 1893, and opened February 18, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From Section 59 northward.
		Per cu. yd.
1	Jeffries & Dameron, Memphis, Tenn	$0.14
2	Scott & Russell, Memphis, Tenn	.17
3	Timothy Sullivan, Memphis, Tenn	.14 55/100
4	W. A. Shippey, Memphis, Tenn	.14 75/100
5	Robert Vance, Memphis, Tenn	.13
6	Thomas J. Bogue, Beulah, Miss	*.12 84/100
7	J. B. Lewis, Luna, Ark	.13 99/100
8	Harvey & McGuire, Greenville, Miss	.16
9	Jennings & Co., Memphis, Tenn	.14½
10	P. F. Lamb, Memphis, Tenn	.14½
11	T. C. Ferguson, Glendale, Miss	.14

*Accepted.

Abstract of proposals for levee work in Upper Yazoo Levee District, received in response to public notice dated April 6, 1893, and opened April 12, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From station 1493 to 1531.
		Per cu. yd.
1	C. A. Winter, Greenville, Miss	$0.25 84/100
2	Timothy Sullivan, Memphis, Tenn	25½
3	J. C. Hodge, Memphis, Tenn	.27½
4	W. A. Shippey, Memphis, Tenn	.25 99/100
5	William R. Harvey, Greenville, Miss	*.20
6	E. R. Shelton, Memphis, Tenn	.29
7	Robert Johnson, Memphis, Tenn	.20½
8	Robert Vance, Memphis, Tenn	.28

*Accepted.

NOTE.—Bids for this work were opened January 24, 1893, but Conner & Lester, who were the lowest bidders, having failed to enter into contract, the work was readvertised.

List of civilian engineers employed on works of improving Mississippi River, First and Second districts, in charge of Capt. S. W. Roessler, Corps of Engineers, from June 1, 1892, to May 31, 1893.

Name and residence.	Time employed.	Pay per month.	Where employed.	Work on which employed.
	Months.			
M. M. Rees, Memphis, Tenn.	12	$200	Memphis	Hopefield Bend and miscellaneous work.
C. W. Sturtevant, Appleton City, Mo.	12	150	Amelia, Ark	Repairs to plant and surveys.
Aug. J. Nolty, Chattanooga, Tenn.	12	150	....do	Construction, Plum Point Reach.
Fred Wigstrand, Memphis, Tenn.	8 3/5	125	Hillhouse, Miss.	Upper Yazoo Levee district.
	1 2/5	150		
A. F. Kilpatrick, Memphis, Tenn.	9 2/30	125	Sessions, Miss	Do.
William Gerig, Columbia, Mo.	12	125	Amelia, Ark	Surveys, gauges, and observations.
S. E. Moore, Memphis, Tenn.	2/30	125	Hillhouse, Miss	Upper Yazoo Levee district.
C. H. Purvis, Helena, Ark	1 1/30	150	Helena, Ark	Upper White River Levee district.
L. Engstfeld, Memphis, Tenn.	2/30	135	Memphis	Do.
C. W. Stewart, Champaign, Ill.	3	175	Memphis	Plum Point Reach, and surveys.
	4 1/30	150		
M. Gardner, Memphis, Tenn.	8 5/30	125	Allisons Landing, Ark.	Upper White Riveer Levee district.
A. L. Dabney, Clarksdale, Miss.	8 5/30	125	Beiths, Ark	Lower White River Levee district.
F. A. Fisher, Memphis, Tenn.	4/30	125	Amelia, Ark	Surveys, gauges, and observations.
Charles LeVasseur, Memphis, Tenn.	4/30	75	New Madrid, Mo.	Improving harbor at New Madrid, Mo.

Approximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, First and Second districts.

Class of property.	No.	Approximate value May 31, 1893.	Class of property.	No.	Approximate value May 31, 1893.
Steamer Minnetonka	1	$22,000	Machine-shop boats	2	$8,000
Steamer Titan	1	19,000	Floating dock	1	4,000
Steamer Itasca	1	5,000	Flat boats	3	450
Steamer Graham	1	7,000	Skiffs	30	300
Steamer Abbot	1	2,500	Storehouse	1	2,000
Pile-drivers	12	10,000	Tools, appliances, and outfit	.....	14,500
Quarter boats	13	14,000	Office furniture	.....	500
Barges	84	90,000	Surveying instruments	.....	1,000
Sand pump	1	2,200			
Hydraulic graders	3	22,500	Total	.....	$226,250
Derrick boat	1	1,300			

FIRST AND SECOND DISTRICTS.

Disbursements made under appropriation for improving Mississippi River, from June 1, 1892, to May 31, 1893.

Contracts made with—	For what made.	Disbursements under contract.	Liabilities under contract.	Total.
Hunter & Frey	Brush and poles	$54 427.65	$700.00	$55,127.65
Edward Hely	Stone	38,360.38	.....	38,360.38
Hugh Morgan	Levee work	15,969.57	.....	15,969.57
DeGuris & Arnold	....do	14,580.70	.....	14,580.70
Augustine McDonell	....do	15,327.71	.....	15,327.71
Patrick F. Lamb	....do	24,468.88	.....	24,468.88
Harvey & McGuire	....do	20,216.10	.....	20,216.10
J. S. McTighe & Co	....do	17,694.87	11,966.00	29,660.87
Hartnett & O'Brien	....do	6,968.29	.....	6,968.29
James H. Cary	....do	20,291.99	.....	20,291.99
C. F. DeGuris & Co	....do	17,536.19	.....	17,536.19
Scott & Russell	....do	14,519.14	.....	14,519.14
Total		260,361.47	12,666.00	273,027.47

Disbursements made otherwise than under contract.

For what expended.	By public notice and sealed proposals.	In open market.	Liabilities.	Total.
Material and supplies	$15,298.80	$69,276.38	$13,158.27	$97,733.45
Subsistence	24,044.70	11,533.97	2,491.18	38,069.85
Services	.....	215,158.30	5,000.00	220,158.30
Tools, appliances, and outfit	1,290.30	13,845.92	327.41	15,463.63
Miscellaneous	.....	9,604.44	1,362.06	10,966.50
Total	40,633.80	319,419.01	22,538.92	382,391.73

Disbursements under appropriation for improving harbor at New Madrid, Mo., from June 1, 1892, to May 31, 1893.

For what expended.	In open market.
Material and supplies	$3,796.70
Subsistence	77.53
Services	2,199.33
Tools, appliances, and outfit	.....
Miscellaneous	65.41
Total	6,138.97

First and Second Districts.

	Cubic yards.
Aggregate yardage of levees on Mississippi River, June 30, 1892	10,354,614
Added by United States up to May 1, 1893	898,790
Added by others up to May 1, 1893	543,106
Total	11,796,510
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	75,000
Aggregate yardage remaining May 1, 1893	11,721,510

Appropriations for improving Mississippi River, first and second districts.

May 31, 1892, balance available		$213,131.11
July 13, 1892, amount appropriated for improving harbor at New Madrid, Mo	$25,000.00	
July 13, 1892, amount appropriated for improving harbor at Memphis, Tenn	25,000.00	
August 5, 1892, amount allotted by the Mississippi River Commission	477,000.00	
December 30, 1892, amount received from proceeds of Government property	27.40	
February 13, 1893, amount received from proceeds of Government property	135.00	
		527,162.40
Total		740,293.51
December 30, 1892, deposited to credit of the Treasurer of the United States, being proceeds of Government property.	27.40	
February 13, 1893, deposited to credit of the Treasurer of the United States, being proceeds of Government property.	135.00	
March 8, 1893, amount transferred to allotment for rebuilding steamer Mississippi	25,000.00	
May 31, 1893, amount expended from June 1, 1892, to May 31, 1893, exclusive of liabilities outstanding May 31, 1892	559,127.03	
May 31, 1893, outstanding liabilities	22,338.92	
May 31, 1893, amount covered by existing contracts	23,000.00	
		629,628.35
Balance available		110,665.16
Amount that can be profitably expended in fiscal year ending June 30, 1895		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor *acts of 1866 and 1867.*

APPENDIX 5.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS, UPON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1893.

GENERAL: I have the honor to submit the following report of operations in the third district, improving the Mississippi River, for the year ending May 31, 1893:

This district extends from the mouth of White River to Warrenton, Miss., a distance of 220 miles. In its improvement work has been undertaken at Lake Bolivar Front, Ashbrook Neck, Greenville, Lake Providence Reach, Delta Point, and Vicksburg Harbor, and levees have been constructed and enlarged in the Lower Yazoo, Upper Tensas, and Middle Tensas Levee districts.

Lake Bolivar Front.—The object of this improvement has been to stop a caving of the bank, which was threatening the destruction of a large levee across the end of Lake Bolivar; 4,400 linear feet of mattress was constructed in 1888–'89, covering 4,250 feet of bank.

Additional description of this work will be found in the Report of the Chief of Engineers for 1889, p. 2704. The revetment consisted of a subaqueous mat 250 feet wide for a distance of 3,300 feet from the upper end, the lower 1,100 feet being covered by a mat of a width of 180 feet, reported as being built on a rapidly rising river.

The upper bank was graded to a slope of 1 on 3 and covered with a brush revetment loaded with stone. The following amounts of material were used in its construction:

Material.	Total.	Per square of 100 feet.	Per running foot.
Brush ..... cords..	9,639	.41	2.25
Poles ..... do....	1,669	.07	.39
Stone ..... cubic yards..	10,154	.....	2.39
Wire ..... pounds..	129,310	5.5	30.4
Cable ..... do....	25,025	2.4	5.88
Iron rods ..... do....	51,924	5.04	12.2

In November, 1889, this work was repaired at the landing by sinking a foot mat 255 by 65 feet, and revetting a space 250 feet wide above. During the past season 2,234 cubic yards of stone have been placed on the upper bank revetment from a stage of about 5 feet above extreme low water to a two-thirds stage at points where the brush showed a tendency to decay.

Soundings were taken over this revetment in December, 1892, on ranges about 100 feet apart, and have been compared with a set taken in June, 1889. These soundings show a general fill over the mats 250 feet wide, while the 180-foot mat has sunk from 5 to 15 feet at its outer edge. On a number of ranges the mat appears to have rotated about an axis situated approximately at the low-water surface, and has assumed a steeper slope, although on three of the sections this action is not manifest. To 2+38 the mat could be detected by the leadsman. Below this range it appears to have been destroyed a distance of about 400 feet. An examination of the sections of 1889 shows that while the outer edge of this mat was in water from 50 to 60 feet deep, thalweg depths of from 90 to 100 feet obtained. In 1892, on ranges from 27+10 to 0+75 the thalweg has moved in closer to the mat.

This revetment has accomplished the purpose for which it has been constructed. The caving has ceased at the end of the lake. To prevent the tendency to undermine observed along the mat 180 feet wide it is proposed during the coming season to construct a mat over it of sufficient width to extend to the line of deepest water.

Ashbrook Neck.—The object of the work at this locality has been to prevent the caving of the bank which was threatening to form a cut-off across the Neck, with its resultant disturbance of the regimen of the river.

The project adopted for this improvement in 1890 consisted of a continuous revetment of the upper side of the Neck at its narrowest part for a distance of 8,000 feet, the mats to extend to the deepest water. During the season 1890-91, 2,820 linear feet of this revetment was constructed. Due to the high stage of the river at which the work was done, the subaqueous mat was given a width of 300 feet, with the exception of the lower 500 feet, which was constructed upon a rapidly rising river, and given a width of but 180 feet. The bank was graded to a slope of 1 to 3, and covered with a brush and stone revetment to a two-thirds stage.

The amount of material expended was as follows:

Material.	Total.	Per square.	Per running foot.
Brush.....cords..	7,901	.708	2.80
Poles.....do....	1,723	.136	.61
Stone.....cubic yards..	12,185	.....	4.32
Wire.....pounds..	92,016	8.3	32.6
Cable.....do....	58,984	6.79	20.9

When work was resumed during the season 1891–'92, it was found that the mat 180 feet wide had been seriously undermined. A mat 300 feet wide was sunk over it, and the revetment continued 2,500 feet below the work of 1890, and 1,500 feet above it, 4,460 linear feet of revetment being constructed. The widths of the subaqueous mats varied from 300 to 250 feet. The bank was graded to a slope of 1 on 4, a brush and stone revetment constructed to 5 feet above the water level at the time the work was done, and the remainder of the slope riprapped with a layer of stone 10 inches thick to a two-thirds stage.

The following amounts of material were used:

Material.	Total.	Per square.	Per running foot.
Brush.....cords..	12,361.5	.661	2.72
Poles.....do....	2,156	.132	.18
Stone.....cubic yards..	24,768	{*.688 †2.89}	5.136
Wire.....pounds..	97,589	.....	19.52
Cable.....do....	74,087	5.1	14.8

*Mat. †Upper bank.

Work was resumed September 15, 1892 and 2,610 linear feet of revetment constructed during the season, completing the project of 1890.

The subaqueous mats were given a width of 250 feet; the upper bank was graded to a slope of 1 on 4 and covered with a riprap of 10 inches of stone to a two-thirds stage. The method of construction was similar to that employed in former years, which has been fully described in preceding annual reports. Detailed statements of the cost of the work, quantities of material used, and of labor applied, will be found in the appended reports of Mr. Arthur Hider, assistant engineer, in local charge, and of Mr. Charles Miller, superintendent of construction.

The amounts of material used were as follows:

Material.	Total.	Per square.	Per running foot.
Brush.....cords..	5,285	.62	2.025
Poles.....do....	1,071	.14	.41
Stone.....cubic yards..	16,017.6	.....	6.137
Wire.....pounds..	59,900	7.7.	22.95
Cable.....do....	27,030	4	13.6

The cost per linear foot was $29.07. Soundings were made over the mats in November, 1892. When compared with a set taken during the construction of the work in 1891, they showed no evidence of the settlement of the revetment observed at other localities.

The levee constructed parallel to the axis of the Neck in 1891, to prevent the flow of water across it, was badly damaged by the flood of 1892. During the flood, however, there accumulated a large mass of drift on the upper side of the Neck, which appears to have caused a checking of the current and a deposition of considerable sand. The levee has not been repaired, but breaks in the drift pile have been closed with brush and fallen trees for the purpose of accelerating the deposit from the river.

Greenville Harbor.—The object of the improvement at Greenville has been to prevent the caving of the bank at this locality, which was rapidly destroying the city. In 1887, 1888, and 1889, the front of the town was protected by a system of spur dikes, which prevented further caving in their vicinity. Their construction has been fully described in preceding reports, but caving has continued in the bend above, which in 1890, during the flood, flanked the upper dikes and threatened the destruction of the remainder.

In 1891 it was determined to commence the revetment of the bend above the city; 6,600 feet of continuous revetment was constructed above the dykes of a character similar to that adopted at Ashbrook Neck, with the exception that the subaqueous mats were given a uniform width of 300 feet.

The amounts of material used were as follows:

Material.	Total.	Per square.	Per running foot.
Brush.....cords..	17,331	.7	3.11
Poles.....do....	3,151	.13	
Stone.....cubic yards..	40,271	*.64 / †3.545	6.12
Wire.....pounds..	137,978	.....	20.9
Cable.....do....	102,018	5	15.46

*Mat. †Upper bank.

During the past season the revetment has been extended 4,450 linear feet up the bend. Additional report of operations will be found in the appended report of the superintendent of construction, Mr. Luther Y. Kerr.

The amounts of material expended were as follows:

Material.	Total.	Per square.	Per running foot.
Brush.....cords..	11,367	.71	2.55
Poles.....do....	2,008	.13	.35
Stone.....cubic yards..	26,484	*.63 / †3.03	5.74
Wire.....pounds..	93,352	5.36	20.98
Cable.....do....	63,432	4.28	14.92

*Mat. †Upper bank.

The cost of the work was $27.08 per linear foot.

Soundings were taken over the revetment on ranges 100 feet apart in April, 1893, and have been compared with similar sets taken in January, 1893, and during the working season of 1891. These soundings show a marked increase of depth along the outer edge of the mat—on some ranges, of over 40 feet. The mats appear to have adapted themselves to this scour, on some ranges by settling at their outer edge; but on others there appears to be a settlement the entire width of the mat.

Lake Providence Reach.—This reach extends from Carolina Landing, Mississippi (517 miles below Cairo), to Island 95, a distance of 35 miles. A brief description of the operations in this reach from 1882 will be found in my last annual report. The destruction of portions of the earlier works necessitated the construction of a new series beginning at Louisiana Bend, the head of the reach. This project was begun in 1889, during which season 6,024 feet of bank revetment was constructed at the head of the bend. During the season 1891–'92 this revetment was extended a distance of 5,000 feet.

During the present fiscal year the revetment has been further extended 5,835 linear feet. The revetment is of a character similar to that constructed at Ashbrook Neck and Greenville. The amounts of material expended were as follows:

Material.	Total.	Per square.	Per running foot.
Brush.....cords..	15,339	.68	2.63
Poles.....do....	2,622	.17	.44
Stone.....cubic yards..	37,952	*.63 / †3.58	6.25
Wire.....pounds..	117,766	5.61	20.14
Cable.....do....	63,110	3.53	10.69

*On mat. †On bank.

The cost of the work was $27.86 per linear foot.

A detailed description will be found in the accompanying report of the superintendent of construction, Mr. George C. Thomas.

Soundings have been taken over this revetment similar to those taken at Greenville and Ashbrook Neck, but comparison can not be satisfactorily made with those taken in 1891, as the earlier soundings were made before the mat was sunk and extensive caving was noted between the time of taking the soundings and sinking the mats; but at the mouth of Old River a tendency to scour at the outer edge of the mat is also noted.

In compliance with a resolution of the Mississippi River Commission I append a report upon a comparison of the low-water soundings taken through Lake Providence Reach since 1882.

Vicksburg Harbor and Delta Point.—The works for the improvement of Vicksburg

Harbor consist, first, of the revetment of Delta Point to prevent its further recession; second, of the basin dredged in front of the city, and a dredged canal connecting it with the river at Kleinston.

Between the years 1878 and 1884, 10,700 feet of bank were revetted at Delta Point. From the records of the office I find that in 1882 and 1883 the width given to the sub aqueous mat was 144 feet; the bank was graded to a slope of 1 on 2½, and covered with a brush revetment.

The following amounts of material were used:

		Per square.	Per running foot.
Brush	cords..	.41	.6
Poles		1.16	1.66
Stone	cubic yards..	.41	.6
Wire	pounds..	1.18	1.70

No repairs have been made to the work for a number of years. A survey was made in November, 1892, and has been compared with soundings taken in 1884 and 1888.

At the upper end of the revetment the same scour is observed at the outer edge of the mat that was noted at Lake Bolivar, Greenville, and Louisiana Bend. Thalweg depths have increased over 50 feet on some sections, and the mat has assumed a much steeper slope. At the lower end of the work there has been a heavy deposit. The upper bank revetment, where not covered with sand, appears to have rotted out.

Upon completion of the work at Ashbrook Neck, the force was transferred to Delta Point for the purpose of constructing a mat to cover the portion of revetment where settlement had been observed. A mat 300 by 685 feet was built, but in sinking was torn from its fastenings and floated to the bar at the lower end of the point. It was then cut in two and towed to the incline of the Vicksburg, Shreveport and Pacific Railway, where it was sunk, it being impossible to tow it further up the river with the towing plant available.

It is proposed to make the repairs to this work during the next fiscal year.

The work of dredging the canal and basin in front of Vicksburg was begun in 1887. In the project then adopted it was proposed to inclose the canal and basin by a dam constructed across Centennial Lake from the city to De Soto Island, and along the island parallel to the canal, for the purpose of limiting the flow of water into the basin during floods and thus reducing the annual deposit of sediment.

The dam has been constructed of material dredged from the canal and basin, and has an elevation of from 25 feet to 35 feet above the zero of the Vicksburg gauge.

At the time of submitting the last annual report dredging was in progress under a contract with the Alabama Dredging and Jetty Company, which was completed July 31, 1892. The following amounts of material have been dredged to that date, measured in scows:

	Cubic yards.
1888	324,941
1890	465,573
1891	331,204
1892	294,447
Total	1,416,165

The river and harbor act approved July 13, 1892, appropriates $80,000 for continuing the improvement of Vicksburg Harbor, and also contains the following proviso: "Improving mouth of the Yazoo River (Miss.) in accordance with the plan of Capt. J. H. Willard, Corps of Engineers, U. S. Army, dated February 4, 1892, contained in House Ex. Doc. No. 125, Fifty-second Congress, first session * * * $75,000." This plan contemplates closing the existing mouth of the Yazoo River and diverting the river through Centennial Lake by the city, and will necessitate the removal of the dam under construction. It was therefore recommended and approved that further work on this dam be suspended, and that the material dredged be deposited at such localities as would best conform to the project for the diversion of the Yazoo River adopted by Congress.

A contract was entered into with the Rittenhouse-Moore Dredging Company to dredge the canal and basin at 16 cents per cubic yard measured in scow, and dredging was resumed January 30, 1893. On May 31, 1893, there had been excavated 244,642 cubic yards, the cut being made to zero on the Vicksburg gauge.

Careful surveys have been made of the canal, in May, 1893, and characteristic sections are submitted herewith. A large fill is noted since August, 1892, estimated at 128,000 cubic yards measured in situ, or about 148,000 cubic yards measured in scows. During the preceding flood the deposit was estimated at 150,000 cubic yards. The total fill since dredging was begun has been about 400,000 cubic yards, the greater part of which has taken place in the canal.

Of the material dredged this season in the canal, over one-half has been a deposit since last year's flood. The removal of such a deposit requires the maintenance of a dredge in the channel at the time it is needed for navigation. Until the inflow from the Mississippi is restricted either by the construction of a dam or the diversion of the Yazoo River, the results attained by dredging in Vicksburg Harbor are not considered commensurate with the cost.

Upon the completion of existing contract, it is recommended that further dredging at this locality be deferred until the completion of the project for the diversion of the Yazoo River.

Further details of the work will be found in the appended report of Assistant Engineer H. St. L. Coppee, in local charge.

Levees, Lower Yazoo district.—This district is situated on the east bank of the river, and extends from the line between Bolivar and Coahoma counties (Mississippi) to Eagle Lake, a distance by river of 215 miles. The length of the levee line is about 190 miles. It is locally known as the Lower Mississippi levee district.

The levee section of 1882 had a crown of from 4 to 6 feet wide, slopes of from one on two and one-half to one on three, and a narrow berm on the river side. The standard section at present adopted by the local authorities has a width of crown of 8 feet and slopes of at least 1 on 3; the width of berm has been increased to 30 feet, and the levees are generally backed by a banquette 8 feet from the crown of the levee, from 20 to 40 feet wide, with a slope of from 1 on 3 to 1 on 5. Below the mouth of White River they have been generally raised to an elevation 1 foot above the estimated height which the flood of 1890 would have attained if there had been no crevasses in the third district. I am indebted to Maj. William Starling, chief engineer of the Lower Mississippi levee district, for the following statement of the yardage in levees in 1882, of levees caved away or abandoned since that time, and of subsequent work by local authorities up to January 1, 1893:

	Cubic yards.
Yardage in place in 1882, after the flood and before repair or rebuilding	6,278,728
Abandoned in 1882	310,002
Leaving available in 1882	5,968,726
Work done by levee board July 1882–January 1893	10,892,685
Total	16,861,411
Abandoned since 1882	2,879,259
Levee-board work in place January 1893	13,982,152
U. S. Government work to June 30, 1892, less Ashbrook Neck	2,595,774
U. S. Government work during fiscal year 1892–'93	793,365
Total	17,371,291

During the year 1892 the local authorities erected 1,500,429 cubic yards. The result of this work has been to increase the height of levees in general 5 feet above that which obtained in 1882, while the area of cross-section to the height of that year's flood has been frequently increased threefold.

The allotment of $200,000 for this subdistrict during the fiscal year ending June 30, 1893, has been expended in enlarging the levee from Hughes to Eutaw (L 403 to 433), Station 2,380 to Station 3,400 of the local levee line. The standard section of the Lower Mississippi levee board was adopted for this work, so as to bring the levee line to standard height below the mouth of White River.

Exterior slopes of 1 on 3 were in general adopted, but where the material of which the levee was composed was sandy and exposed to wave-wash the slope was increased to 1 on 4. An abstract of the various contracts is appended.

Under the allotment of $150,000 for the fiscal year ending June 30, 1894, contracts have been awarded for enlarging the levee as follows:

Stations.		Estimated yardage	Price per cubic yard.	Name of contractor.
From—	To—			
		Cubic yards	*Cents.*	
0	290	118,000	19	Starling & Smith Co.
407	808	63,500	18¾	W. L. Withers & Co.
808	900	74,300	17¾	W. L. Withers & Co.
900	1000	70,000	19	Timothy Sullivan.
1000	1200	128,000	18	Starling & Smith Co.
1200	1264	61,000	16⅜	Arnold, De Garis & Co.
1330	1423	43,000	17¼	W. L. Withers & Co.
Leota	(L 510)	65,000	14 $\frac{45}{100}$	Merritt Williams.

These stations are located between the Bolivar-Coahoma county line (L 365) and Rosedale (L 397). The standard height adopted for these levees is the same as that for Government levees in the Upper Tensas district, three feet above the highest known water.

While the levee line through this subdistrict is considered the strongest of any in the third district, it has the defect of being located at numerous localities close to caving banks.

The standard height adopted by local authorities is also less than that to which the new levees on the opposite bank of the river are being constructed.

A profile of the levee line giving the flood heights of 1882, 1890, and 1892 accompanies this report, based upon a survey of 1888 by the Lower Mississippi levee board, with enlargements since that date plotted to net grade.

Levees, Upper Tensas district.—This district is situated on the right bank of the river and extends from the Arkansas River to the Louisiana-Arkansas state line. It is divided into three local levee districts, viz: The Red Fork levee district, which extends from the Desha-Lincoln county line on the Arkansas River to the mouth of Cypress Creek; the Desha Levee district from the mouth of Cypress Creek to the Desha-Chicot county line, and the Chicot Levee district, which contains Chicot County.

From the president of the Red Fork levee district I have the following statement of the condition of its levee line: Length of the line in 1882, 30 miles, containing about 1,500,000 cubic yards. Since that time there has been destroyed by caving banks and crevasses about 500,000 cubic yards, of which 126,000 cubic yards have been replaced. January 1, 1893, the length of levee line intact was 18 miles. No work has been done in this subdistrict by the General Government. Its levees are separated from the levees along the Mississippi River by Cypress Creek, but it covers the head of the levee system, and a crevasse in its levees floods the Tensas Basin by flanking the front line.

The levee line proper begins at Amos Bayou, about 17 miles north of Arkansas City, extends along Cypress Creek to Lucca Landing, on the Mississippi, and thence to the Louisiana state line, a distance of 84.8 miles. In 1882 there were numerous breaks. Such levees as remained after the flood had, in general, a width of crown of 4 feet, and slopes of from 1 on 2 to 1 on 3. They were of defective construction, containing stumps, logs, and growing trees, and appear to have been constructed in accordance with the whims of the planters along whose fronts they were located.

I am unable to give an accurate statement of the yardage in the levees, as the local boards have kept no record of the work they have done, with the exception of the amounts they have expended. A large part of this expenditure has been for the high-water protection of the levees, and has added little to the yardage in the line. A careful survey of the levee line was, however, completed in 1888, by the General Government. Based on that survey, and assuming that the yardage erected by the local boards and the State of Louisiana between 1882 and 1888 was equal to the amount in the levees which were abandoned between those dates, I deduce the following approximate Statement of Yardage:

	Cubic yards.
In levees in 1882	1,788,304
Built by the U. S. Government to June 30, 1892	3,098,606
Built by the Tensas Basin levee board 1891-'92	176,073
Built by Desha levee board 1891-'92	27,941
Built by Chicot levee board (estimated)	100,000
	5,190,924
Less levee abandoned 1888-'92	642,000
Total yardage in levees in 1892 *	4,548,924
Levees built by U. S. Government during fiscal year ending June 30, 1893.	1,202,884
Levees built by Tensas Levee Board, 1893	41,187
Total	5,792,995
Less levees abandoned in 1893	150,000
Total yardage in levees 1893	5,642,995

* Of this amount 423,555 cubic yards have been erected by the Tensas Levee Board of Louisiana since 1882.

The levees constructed by the United States prior to 1890 had, generally, a width of crown of 6 feet, and slopes of 1 on 3. Since that date they have been given a width of crown of 8 feet, slopes of 1 on 3; through sloughs or bayous backed by a banquette from 8 to 10 feet from the top of the levee, and of widths of from 20 to 40 feet; the established grade is 3 feet above the highest known water.

I submit with this report a typical section of a levee of 1882 enlarged to the sections of 1888 and 1892. There is also shown on the same sketch the levee of 1882 topped during floods, a form of levee not infrequently found in this subdistrict.

The allotment of $310,000 for the fiscal year 1892-'93 for the Upper Tensas district has been expended in closing the crevasses that occurred during the flood of 1892, and in enlarging the weak portions of the levee line at the following localities:

Locality.	Character of work.	Distance from Cairo.	Yardage.
		Miles.	*Cubic yards.*
Middle Place	Loop enlargement	R...430	75,334.1
Panther Forest	Crevasse	R...451	172,435.1
Do	Enlargement	R...451	326,003.1
Pastoria	....do	R...466	28,186.3
Luna	New loop	R...468	337,229.2
Upper Leland	Enlargement	R...469	95,382.2
Lower Leland	Crevasse	R...485	10,962.5
Lakeport	....do	R...496	6,941.5
Do	Enlargement	R...496	85,493.7
Brooks Mill	Crevasse	R...506	64,895.7
Total			1,202,384

Under the allotment of $300,000 for the fiscal year ending June 30, 1894, the following contracts have been awarded:

Levee.	Station. From—	Station. To—	Distance from Cairo.	Estimated yardage.	Price per cubic yard.	Contractor.
			Miles.	*Cubic yards.*	*Cents.*	
Opossum Fork to Lucca	374	414	R....427	60,000	21	Starling & Smith Co.
Belleview	95	127	R....465	53,000	18.5	Arnold, Degaris & Co.
Upper Pastoria	127	164	R....466	55,000	20	The Whitehill Co.
Dulaneys Loop	624	690	R....485	79,000	15.94	Ernest Hyner.
Leland	690	790	R....486	120,000	18.94	Do.
Vaucluse	832	862	R....487	60,000	27	McLaughlin Brothers.
Lakeport:						
First section	1,216	1,292	R....494	56,000	12	J. S. Peak.
Second section	1,292	1,368	R....495	79,000	15	J. B. Lewis.
Below Lakeport	40	105	R....497	140,000	17.98	Ernest Hyner.
Adams Front	105	210	R....498	102,000	14.49	Kilpatrick & Storer.
Florence Front	210	306	R....500	87,500	14.49	Do.
Keigers Front:						
First section	50 stations		R....505	67,000	12	J. S. Peak.
Second section	30 stations		R....505	64,000	13.88	Timothy Sullivan.
Third section	23 stations		R....505	79,000	13.99	Do.

In anticipation of a flood in 1893 about $100,000 was left available. With this fund it is expected that the crevasses that have occurred this season can be closed, and the enlargement of the levee line be made continuous from Opossum Fork to Brooks Mill, with the exception of the railroad embankment at Arkansas City, a section of levee from the end of the enlargement of Panther Forest to Linwood, which it is expected will have to be abandoned within the next three years due to caving banks, and between Sunnyside and Lakeport, where the desired right of way can not be obtained. At Lucca Landing (R 427) and Eunice (R 442), however, the levee will only be enlarged to the section of 1888. The enlargement of the Fulton Lake Levee is under construction by the Tensas levee board of Louisiana.

Levees, Middle Tensas District.—The Middle Tensas Levee District extends from the Louisiana-Arkansas State line to Bedford, opposite Warrenton, and forms a portion of the Fifth Louisiana Levee District. The length of the line is 87.33 miles. Through the courtesy of Mr. H. B. Richardson, chief State engineer of Louisiana, I am enabled

to submit the following resumé of the levees in the Middle Tensas District from February 1, 1882, to February 20, 1893:

	Miles.	Cubic yards.
Condition of levee line February 1, 1882	88.67	3,631,400
Crevasse openings in 1882	9.81	450,400
Remained standing after flood of 1882	78.86	3,181,000
Levees constructed by State and local authorities since flood of 1882	.....	3,723,500
Raised and enlarged by State and local authorities	.....	2,335,053
Built by United States to June 30, 1892	.....	1,994,558
Built by United States during fiscal year ending June 30, 1893	.....	460,216
Total	157.03	11,694,327
Levee line abandoned since 1882	69.70	4,407,400
Existing levee line	87.33	7,286,927

During the last fiscal year the Fifth Louisiana Levee District has erected 257,627 cubic yards, which has been principally expended in enlarging the Louisiana Bend Levee (R. 522) and the levee in front of Lake Providence (R. 542).

The allotment of $110,000 for this subdistrict has been expended in the construction of a levee from Millikens Bend to Cabin Teele (R. 581 to R. 584), to replace a levee which is rapidly caving into the river. Under the allotment of $100,000 for the fiscal year ending June 30, 1894, the following contracts have been made for the construction of a levee at Villa Vista (R. 574) to replace a levee which it is expected will be breached by caving banks before the next flood.

	Estimated yardage.	Price per cubic yard.	Contractor.
	Cubic yards.	*Cents.*	
First section	125,000	14.93	Manoah V. Henry.
Second section	123,000	18.45	John Scott & Son.
Third section	126,000	17	W. L. Withers & Co.

The levees recently constructed by the General Government have a width of crown of 8 feet, slopes of 1 on 3. Their grade is 3 feet above the flood of 1890. Their height is not as great as is desirable, and the higher levees should be backed by a banquette, but the levee line has been located too close to the river banks, and the funds allotted by the General Government are entirely inadequate to replace the levees which I anticipate will cave into the river in the next three years.

The floods of 1892 and 1893.—At the date of my last annual report the flood of 1892 was at its maximum. This flood attained a height in the third district only exceeded by that of 1893. In the following table are given the maximum heights at the gauge stations of the third district during the floods of 1882, 1890, 1891, and 1892, together with those at Helena and Cairo, and at Little Rock and Clarendon, Ark., while the crest of the flood was passing the mouth of White River:

Station.	1882.	1890.	1891.	1892.
	Feet.	*Feet.*	*Feet.*	*Feet.*
White River	48.40	50.4	47.7	49.3
Arkansas City	47	49.5	48.2	49.9
Greenville	41.68	43.45	43.25	44.45
Lake Providence	38.32	41	41.1	41.9
Vicksburg	48.75	49	48.1	48.4
Cairo	51.87	48.8	46.2	48.3
Helena	47.2	47.7	44.7	45.7
Little Rock	25.7	23.9	17.7	28.2
Clarendon	.....	36.6	29	32.6

The effect of leveeing the Tensas Basin in raising the flood heights is clearly exhibited in this table, for while the flood of 1892 was 1.5 feet below that of 1882 at Helena, it exceeds it at the mouth of White River by nine-tenths of a foot, at

Arkansas City by 2.9 feet, at Greenville by 2.8 feet, and at Lake Providence by 3.1 feet.

The following are the maximum discharges of the river and the estimated flow past the latitude of Lake Providence for the corresponding years:

[In cubic feet per second.]

	1882.	1890.	1891.	1892.
Measured discharge	1,057,000	1,288,000	1,346,000	1,433,000
Estimated flow	2,000,000	1,720,000	1,400,000	1,760,000

An increase in the maximum river discharge since 1882 of at least 376,000 cubic feet is noted, about 35 per cent.

During the flood six crevasses occurred, which were confined to the Upper Tensas Levee District. The levees of Mississippi and Louisiana in the third district successfully withstood the strain brought upon them. The following table gives the width, location, and maximum measured discharges of the various crevasses:

	Location.	Date.	Width.	Maximum discharge per second.
		1892.	*Feet.*	*Cubic feet.*
Railroad embankment at Arkansas City	R....439	June 2..	2,279	14,520
Panther Forest	R....451	May 13..	2,327	94,507
Upper Leland	R....470	June 22..	420	18,300
Lower Leland	R....484	May 25..	435	15,709
Lakeport	R....496		200	
Brooks Mill	R....506	May 9...	715	83,400

The crevasse at Lakeport occurred as the river was falling, and was not reported in time to obtain its discharge.

While a disastrous flood would have been caused by the water that poured through these crevasses, a considerable portion of the Tensas Basin would have escaped overflow if it had not been for a flood which swept across Amos Bayou around the head of the levee system from breaks in the levees along the Arkansas River.

Cypress Creek is the natural outlet of a number of bayous at the head of the Tensas Basin. To allow a drainage to this area, the levee line leaves the Mississippi River at Cypress Creek and extends along that stream to the banks of Amos Bayou, which in 1882 were above overflow. But due to the increase in flood heights that has been caused by the construction of the levees, and to breaks which have occurred in the levees on the Arkansas River, the floods of 1890, 1892, and 1893 have overflowed the Amos Ridge, flanking the levee line. The maximum discharge from this source has been measured since 1890 along the railroad from Arkansas City to Trippe, and is as follows:

	Cubic feet per second.
1890	50,000
1891	5,000
1892	300,000
1893	97,000

The large flow of 1892 was due to an abnormal flood in the Arkansas River. The measured discharge of 1893 has also arisen from the same source, but since the flood of the Arkansas has subsided a second rise in the back water has been observed, which can only be attributed to the Mississippi River.

By extending the levee along Amos Bayou to the land above overflow on Bayou Bartholomew this year's flow from the Mississippi would be cut off, but this line would afford inadequate protection to a flood in the Arkansas River like that of 1892. The only protection from the Arkansas River is a strong line of levees from Pine Bluff to the mouth of Cypress Creek, and if the leveeing of the Saint Francis front raises the flood height as much as has been caused by the closing of the Tensas Basin, a levee across Cypress Creek will also be required, in which case it will be necessary to drain that stream into some of the bayous south of the existing levee system.

The flood of 1893 has already attained a greater height from the mouth of White River to Greenville than that of 1892; from Greenville to Lake Providence it varies from one-tenth below that of 1892 to two-tenths above; below Lake Providence this flood has been exceeded by that of 1892.

Crevasses have occurred as follows: Adams' Front (R. 497), May 11; Keiger's Front (R. 505), May 14; Matthews Bend (R. 508), May 15; Wylys (R. 515), May 23; Station 202 on Cypress Creek levee, May 29.

Financial statement.

LAKE BOLIVAR FRONT.

Balance May 31, 1892		$6,000.00
Expended to May 31, 1893		3,377.20
Balance May 31, 1893		2,622.80
In hand	$2,622.80	
Available balance May 31, 1893		2,622.80
Expenses apportioned:		
Labor on construction		922.09
Material for construction		876.57
Subsistence		307.48
Cost of plant, repairs, and outfit		243.69
Care of public property		34.50
Towage and steamer expenses		787.92
Administration and office expenses		9.60
Miscellaneous		195.35
Total		3,377.20

Financial statement.

ASHBROOK NECK.

Balance May 31, 1892		$111,196.84
Expended to May 31, 1893	$85,182.26	
Transferred to plant third district	25,000.00	
		110,182.26
Balance May 31, 1893		1,014.58
In hand		1,014.58
Less amount covered by liabilities		1,014.58
Expenditures apportioned:		
Labor on construction		20,263.35
Material for construction		34,595.06
Subsistence		7,911.36
Cost of plant, repairs, and outfit		10,161.49
Care of public property		1,527.51
Towage and steamer expenses		6,979.08
Administration and office expenses		1,704.58
Medicine and medical attendance		688.79
Miscellaneous		1,318.04
Total		85,182.26

Financial statement.

PLANT THIRD DISTRICT.

Balance May 31, 1892	$15,464.80
Allotted during current fiscal year	50,000.00
March 18, by transfer from Ashbrook Neck	25,000.00
Total	90,464.80
Expended to May 31, 1893	84,783.09
Balance May 31, 1893	5,681.71
In hand	5,681.71
Less liabilities	5,681.71

Expenditures apportioned:	
Labor on repairs	$37,724.01
Material for repairs	19,384.91
Care of plant, labor	4,613.77
Subsistence	14,891.72
Cost of plant, outfit, and supplies	6,683.63
Administration and office expenses	281.36
Miscellaneous	1,200.69
Total	84,783.09
Amount that can be profitably expended during the fiscal year ending June 30, 1895	113,000.00

Financial statement.

SURVEYS, GAUGES, AND OBSERVATIONS.

Balance May 31, 1892	$525.38
Allotted during current fiscal year	10,000.00
	10,525.38
Expended to May 31, 1893	10,226.96
Balance May 31, 1893	298.42
In Treasury	1,000.00
Due other allotments	701.58
Balance	298.42
Less liabilities	298.42
Expenditures apportioned:	
Pay, gauge observers	120.00
Surveys	6,372.55
Steamer expenses	2,949.99
Outfit, material, and stationery	433.00
Miscellaneous	351.42
Total	10,226.96
Amount that can be profitably expended during fiscal year ending June 30, 1895	12,000.00

Financial statement.

LOWER YAZOO LEVEE DISTRICT.

Balance May 31, 1892	$3,089.66
June 7, 1892, by transfer from general service	4,000.00
Allotted during fiscal year	200,000.00
	207,089.66
Expended to May 31, 1893	182,170.68
Balance May 31, 1893	24,918.98
In Treasury	24,000.00
In hand	918.98
	24,918.98
Less liabilities	9,918.98
Available balance May 31, 1893	15,000.00

is given to the forces acting by the revetment of the bends. An increased depth may be obtained for one season, but the continual caving of a bend above may be expected to so change the direction of the river currents that they will be acting on bars or banks outside of the improved channel and filling the channel up with the material they have scoured out.

The bank revetment which was constructed in 1883 and 1884 in Lake Providence Reach was destroyed. The cause is believed to be the narrow width given to the mats, as well as an insufficient thickness. No revetment constructed since that date in the third district has been lost, with the exception of exposed ends which have been flanked by caving above or below them. There has been noted, however, a general deepening of the river at the outer edge of the mat, which has occasioned a greater or less settlement. With the narrow mats at Lake Bolivar and Delta Point, it is deemed prudent to extend the revetment to the thalweg of the river, to prevent the continuance of this undermining action.

At Greenville I do not consider the situation at all critical. The mats were given as great a width as could be conveniently constructed on our mat barges, in anticipation of this very action. The maximum existing depths at the date of construction would have been covered by a 250-foot mat.

During the flood of 1890 there had been an abnormal caving of the bank, in some places exceeding 900 feet, accompanied by an abnormal fill in the river channel, thalweg depths of about 40 feet at low water being found, while low-water depths in bends in the third district of 80 feet are not infrequent. When the forces in the river are prevented from caving away the banks a condition exists similar to that in a bend where erosion is slow, and the river may be expected to try to assume a similar form of cross section, and thalweg depths exceeding 80 feet should result. The mats have in general adjusted themselves to their new beds in a satisfactory manner, and the fact that on some sections a settlement is observed the entire width of the mat does not, in my judgment, afford sufficient reason for the abandonment of the existing form of revetment.

The fact that the revetment of Delta Point has stood for ten years, though containing but one-half the material per square foot that has been put in the revetment of 1892, and with mats only one-half as wide, would indicate that in certain localities the existing form of revetment is sufficiently strong to hold the bank.

If the fine sand found in some portions of the Greenville Front, or the mud found at Louisiana Bend passes through the revetment, such sections should receive local treatment. To construct a revetment sufficiently thick to prevent such action would at localities where the soil is firmer be an unnecessary expense. These sections are of a limited extent even on a given front, and can be covered by an additional mat should the settlement ever become so great as to necessitate such action. While a still greater deepening of the river is to be expected at Granville, it is not yet evident that the revetment can not again adjust itself to the required change.

A financial statement accompanies this report.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain of Engineers.

Gen. C. B. COMSTOCK,
Colonel of Engineers, U. S. A.,
President Mississippi River Commission.

Financial statement.

LAKE PROVIDENCE REACH.

Balance May 31, 1892	$34,558.52	
Allotted during current fiscal year	176,000.00	
		$210,558.52
Expended to May 31, 1893		185,833.49
Balance May 31, 1893		24,725.03
In treasury		15,000.00
In hand		9,725.03
Less amount covered by existing contracts and liabilities		24,725.03

Expenditures apportioned:	
Labor on construction	$38,222.27
Material for construction	88,594.14
Subsistence	12,584.94
Cost of plant, repairs, and outfit	18,265.87
Care of public property	1,841.49
Towage and steamer expenses	23,278.01
Administration and office expenses	2,067.74
Medicine and medical attendance	907.38
Miscellaneous	71.65
Total	185,833.49
Amount that can be profitably expended during fiscal year ending June 30, 1895	500,000.00

Financial statement.

VICKSBURG, MISS., AND DELTA POINT, LA.

Balance May 31, 1892	$44,916.31
Expenditures May 31, 1893	38,876.69
Balance May 31, 1893	6,039.62
In Treasury	5,000.00
In hand	1,039.62
Available balance May 31, 1893	6,039.62
Expenditures apportioned:	
Vicksburg, Miss.:	
Cost of plant, outfit, and repairs	2,161.99
Subsistence	1,050.90
Care of public property	824.17
Administration and office expenses, and inspection	1,045.77
Dredging	24,705.44
Mileage, traveling expenses, and miscellaneous	84.84
Delta Point, La.:	
Labor on construction	2,274.68
Material for construction	4,395.93
Subsistance	421.36
Cost of plant, repairs, and outfit	279.57
Care of public property	231.33
Towage and steamer expenses	1,268.71
Administration and office expenses	72.00
Miscellaneous	60.00
Total	38,876.69

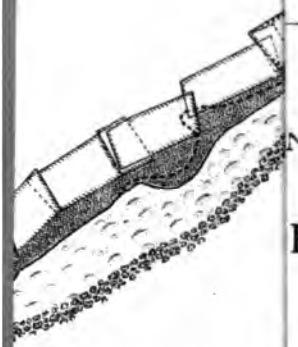
Financial statement.

GREENVILLE, MISS.

Balance May 31, 1892	$49,711.27
Expended to May 31, 1893	49,711.27
Expenditures apportioned:	
Labor on construction	6,383.39
Material for construction	32,983.90
Subsistence	3,124.69
Cost of plant, repairs, and outfit	3,042.87
Care of property	349.00
Towage and steamer expenses	1,400.39
Administration and office expenses	1,132.87
Medicine and medical attendance	286.72
Miscellaneous	1,007.44
Total	49,711.27

No. 1

1892-93.
s years.



PI RIVER COMMISSION

HIRD DISTRICT

WNSEND, CORPS OF ENG'RS., U.S.A.

— IN CHARGE

MAP

NG IMPROVEMENT

OF

ROOK NECK

SCALE

Meters

Feet

NUAL REPORT JUNE 1, 1893

CAPT. OF ENG'RS

Eng 93

Expenditures apportioned:	
Levee construction and repairs	$167,537.59
Engineering and office expenses	9,319.68
High-water protection	5,313.41
Total	182,170.68
Amount that can be profitably expended during fiscal year ending June 30, 1895	200,000.00

Financial statement.

UPPER TENSAS LEVEE DISTRICT.

Balance May 31, 1892	$22,719.40
June 7, 1892, by transfer from general service	5,000.00
Allotted during current fiscal year	310,000.00
Overpayment on vouchers	5.17
	337,724.57
Expended to May 31, 1893	310,245.25
Balance May 31, 1893	27,479.32
In Treasury	43,000.00
Due other allotments	15,520.68
	27,479.32
Less amount covered by existing contracts and liabilities	12,479.32
Available balance May 31, 1893	15,000.00
Expenditures apportioned:	
Levee construction and repairs	264,495.90
Engineering and office expenses	11,361.98
High-water protection	34,387.37
Total	310,245.25
Amount that can be profitably expended during fiscal year ending June 30, 1895	500,000.00

Financial statement.

MIDDLE TENSAS LEVEE DISTRICT.

Balance May 31, 1892	$5,977.15
Allotted during current fiscal year	110,000.00
	115,977.15
Expended to May 31, 1893	98,635.96
Balance May 31, 1893	17,341.19
In Treasury	7,000.00
In hand	10,341.19
	17,341.19
Less liabilities	7,341.19
Available balance May 31, 1893	10,000.00
Expenditures apportioned:	
Levee construction and repairs	85,757.11
Engineering and office expenses	4,563.26
High-water protection	8,315.59
Total	98,635.96
Amount that can be profitably expended during fiscal year ending June 30, 1895	250,000.00

Financial statement.

IMPROVING HARBOR AT VICKSBURG, MISS.

Act July 13, 1892 (special appropriation)	$80,000.00
Expended to May 31, 1893	24,187.74
Balance May 31, 1893	55,812.26
In Treasury	60,000.00
Due other allotments	4,187.74
	55,812.26
Less amount covered by existing contracts and liabilities	37,512.26
Available balance May 31, 1893	18,300.00
Expenditures apportioned:	
Cost of plant repairs and outfit	8.30
Care of public property	481.50
Administration and office expenses	20.00
Dredging	23,643.70
Mileage, traveling expenses, and miscellaneous	34.24
Total	24,187.74

Financial statement.

IMPROVING HARBOR AT GREENVILLE, MISS.

Act July 13, 1892 (special appropriation)	$100,000.00
Expended to May 31, 1893	94,758.46
	5,241.54
In Treasury	5,000.00
In hand	241.54
Available balance May 31, 1893	5,241.54
Expenditures apportioned:	
Labor on construction	26,764.39
Material for construction	46,876.11
Subsistence	4,206.99
Cost of plant, repairs, and outfit	7,720.78
Care of public property	1,338.16
Towage and steamer expenses	6,212.48
Administration and office expenses	1,182.60
Medicine and medical attendance	425.50
Miscellaneous	31.45
Total	94,758.46
Amount that can be profitably expended during fiscal year ending June 30, 1895	200,000.00

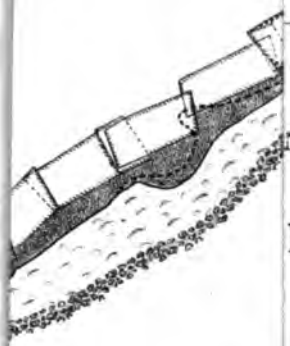
Financial statement.

DRY DOCK, THIRD DISTRICT.

Balance May 31, 1892	$11.43
Expended to May 31, 1893	11.43

No. 1

F 1892–93.
s years.



PI RIVER COMMISSION

HIRD DISTRICT

WNSEND, CORPS OF ENG'RS., U.S.A.

— IN CHARGE

MAP

NG IMPROVEMENT

OF

ROOK NECK

SCALE

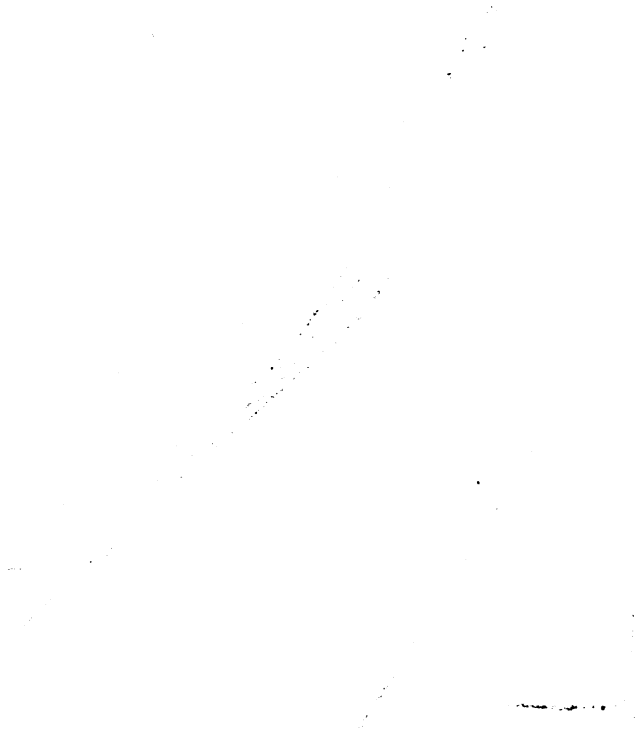
Meters

Feet

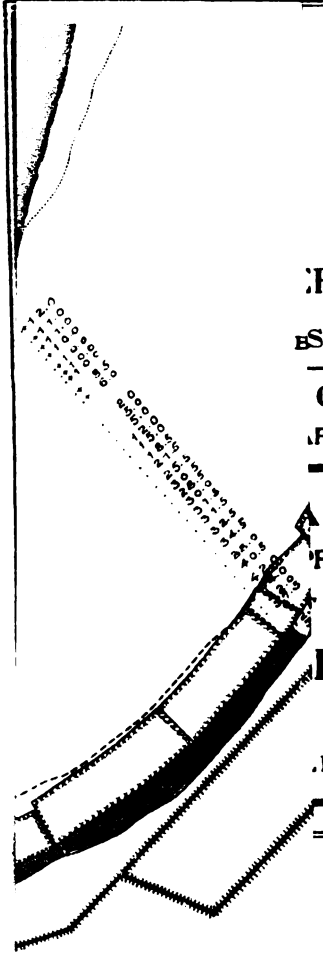
NUAL REPORT JUNE 1, 1893

CAPT. OF ENG'RS

Eng 93



No. 2.



:R COMMISSION

ESTRICT ———

CORPS OF ENG'RS. U.S.A.

ARGE ———

AP

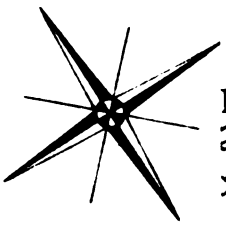
ROVEMENT

E HARBOR

.E

Meters

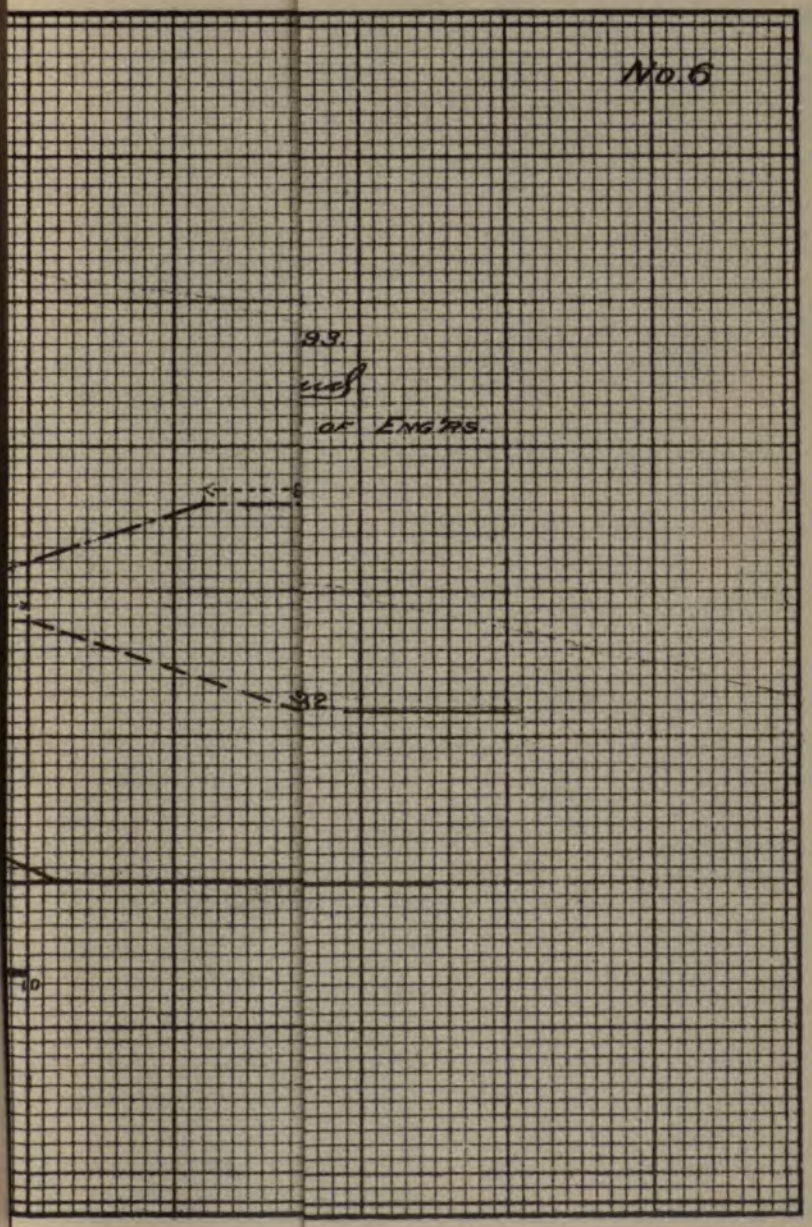
Feet



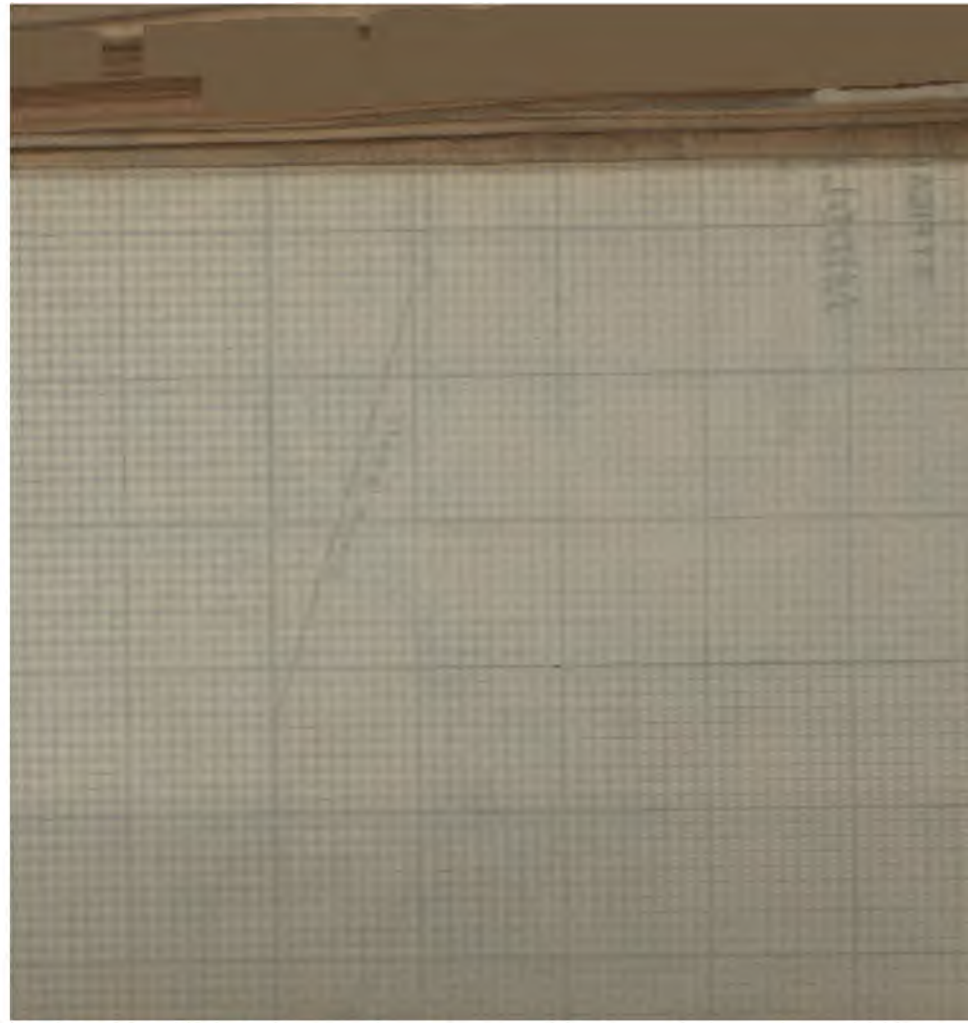
Report June 1. 1893.

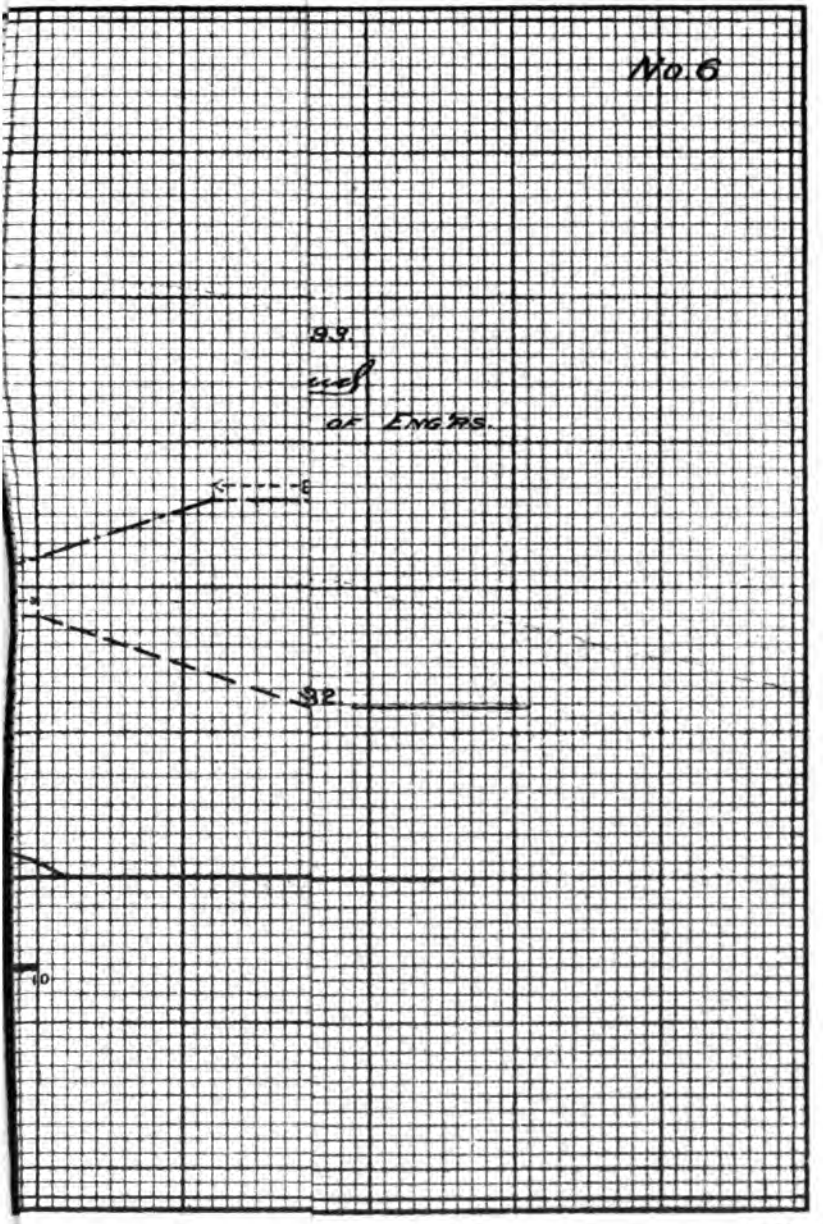
Capt. Corps of Engrs, U.S.A.

Eng 93

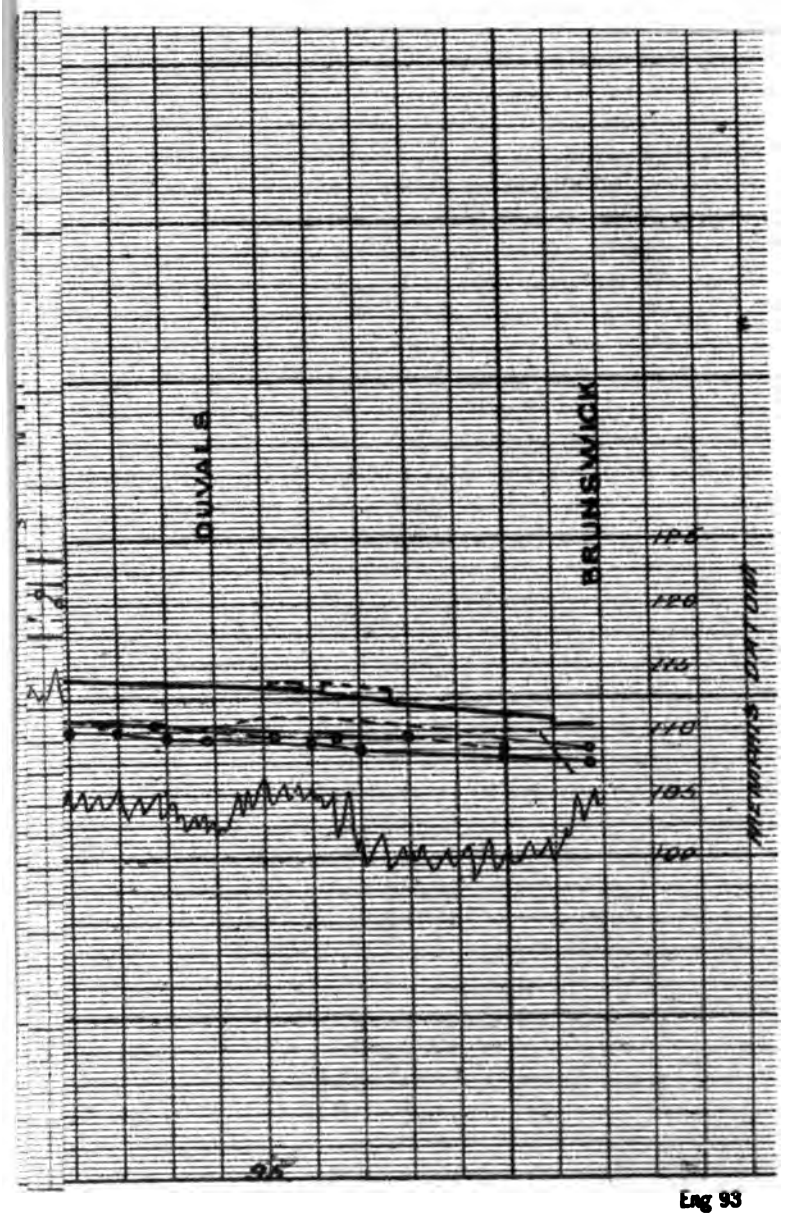


Eng. 93





Eng. 93



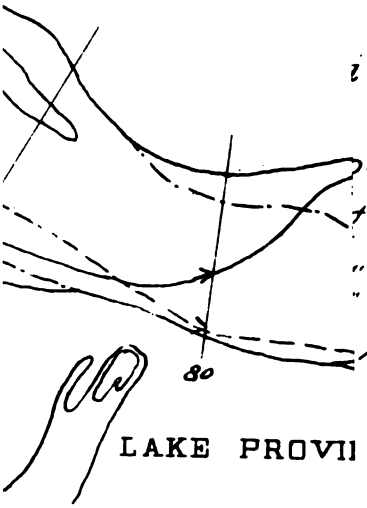
Eng 93

OMEGA
MORANCY
BEDFORD
115
110
105
100
95
90
85

No. 9

S

: REACH



ings of

00

t Oct. '82
" '91
" " '82
" " '91

ARTHUR HIDER
ASS'T. ENG'R.

80

LAKE PROVII

N

A

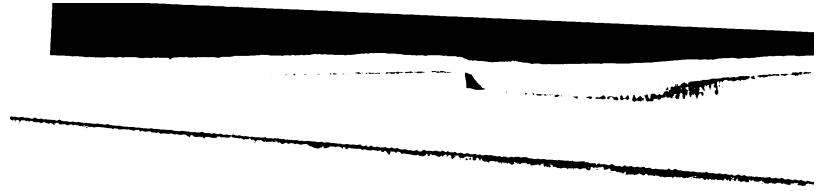
1

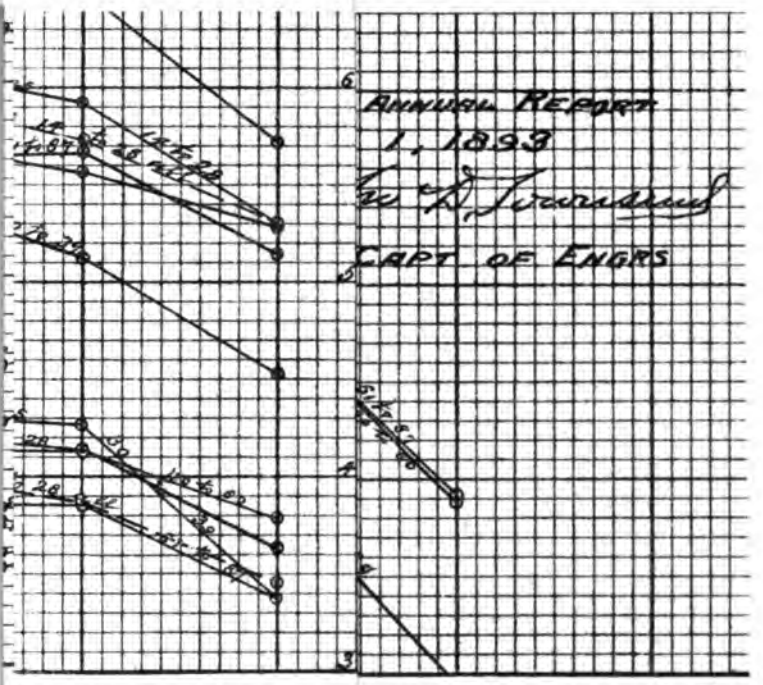
A.

'1892

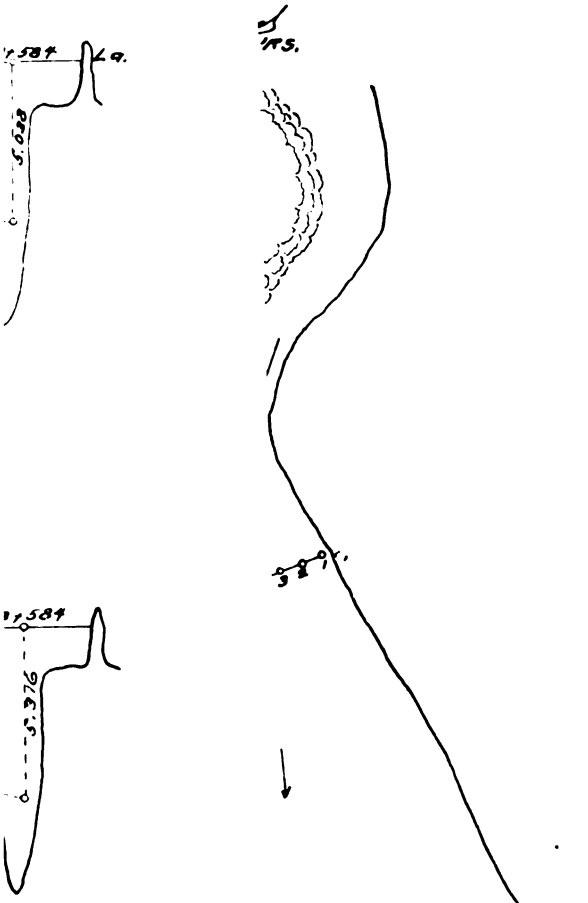
VE 4 1893.
D. Townsend
CAPT. OF ENG'RS.

Eng 93




Annual Report
1, 1893
Capt. of Engrs

No. 11.

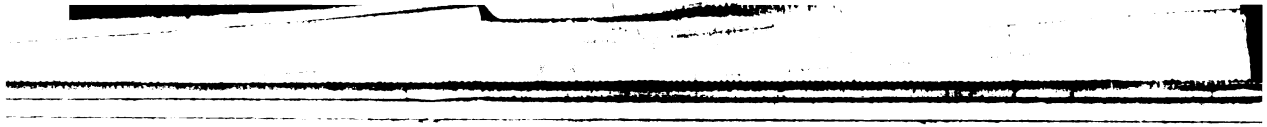


ETCH of RIVER in

▸ DENOTE POSITI
➤ " "

PILCHERS PT. LA.
OCT. 18TH 1892

Eng 93



No. 12.

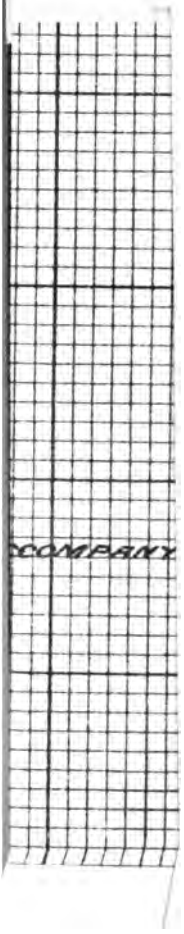
Lachesis

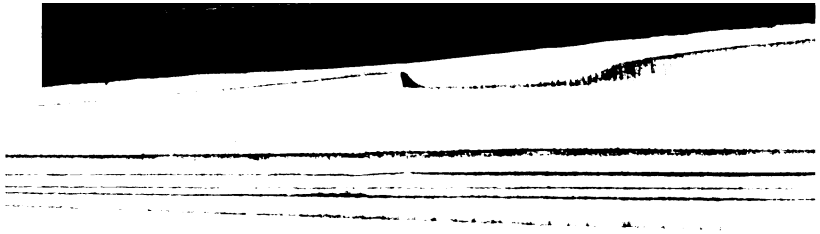
Vertical = 20ft.
" 7ft per sec.
" 20,000 c.m. ft per sec.

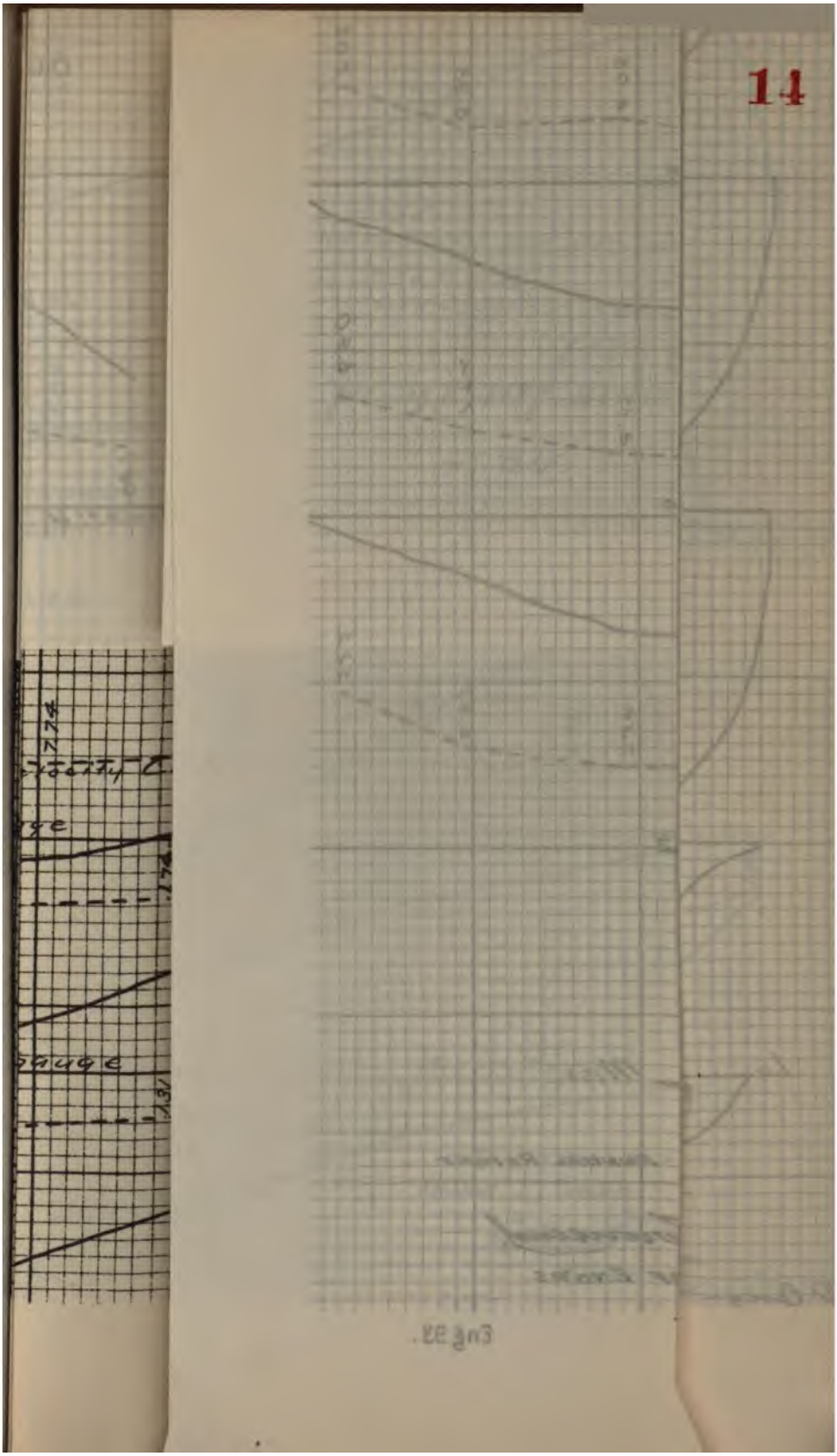
Pitchless Pt. Oct 19th 1892

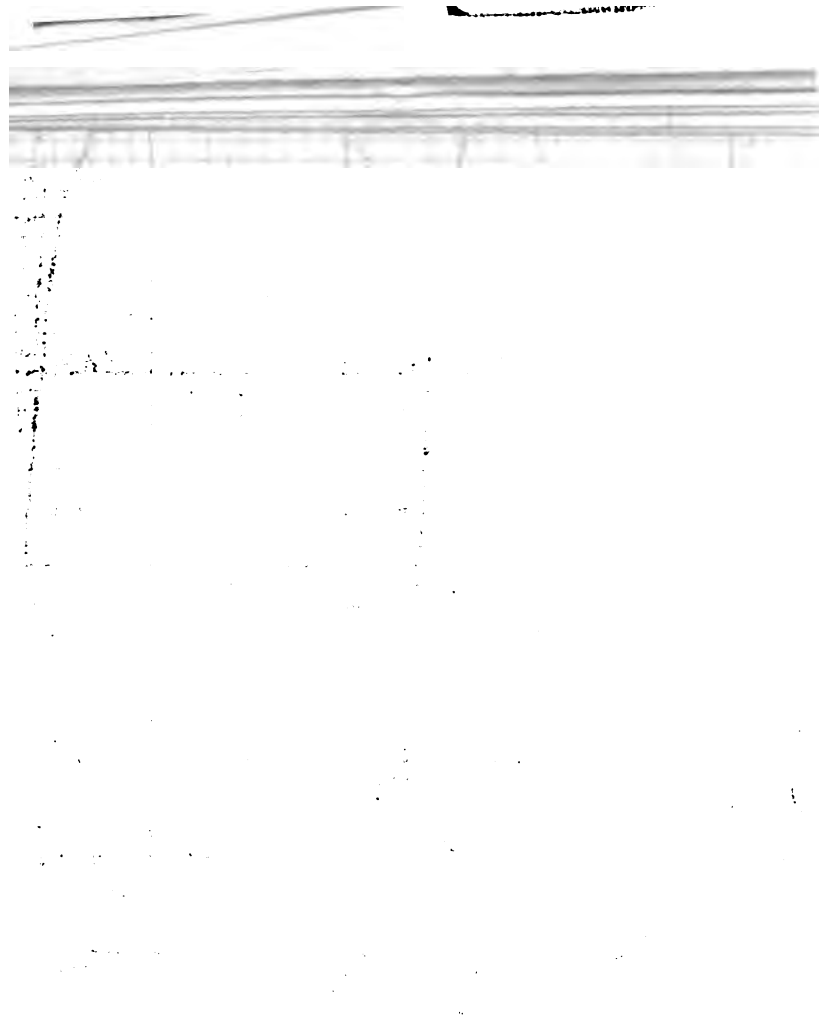
Arthur Hickey
Asst Engr

ACCOMPANY ANDS
ENGRS.


COMPANY







APPENDIX 5 A.

REPORT OF ASSISTANT ENGINEER ARTHUR HIDER ON WORK AT GREENVILLE, ASHBROOK NECK, AND LOUISIANA BEND.

GREENVILLE, MISS., *March 10, 1893.*

SIR: I submit below final reports of Greenville Harbor, Ashbrook Neck, and Louisiana Bend improvements, prepared by the superintendents of the respective works.

As these reports give a complete statement of the cost in detail, and a full description of the work, they are forwarded as the final reports of these improvements.

A comparison is given below of the labor cost per unit, the quantities of material used, and the average cost per linear foot of the revetment works at Ashbrook Neck, Greenville Harbor, and Louisiana Bend last season.

Comparative statement.

COST PER UNIT FOR LABOR.

Kind of work.	Ashbrook Neck.	Greenville Harbor.	Louisiana Bend.
Mat work, per square	$1.356	$1.519	$1.452
Grading and dressing bank, per linear foot	2.387	1.845	1.003
Paving slope and revetment, per square	1.603	1.855	1.676
Same (pile-driver)	1.423	1.570	1.344
Same (wheelbarrows)	1.208	.760	.788
Loading stone, per cubic yard	.341	.537	.374

QUANTITY OF MATERIAL USED.

Brush, per square of mat ..... cords	.62	.71	.85
Poles, per square of mat ..... do	.14	.13	.17
Stone, per linear foot ..... cubic yards	6.14	5.74	6.25
Wire, per linear foot ..... pounds	20.96	20.98	20.14
Wire strand, per linear foot ..... do	13.60	14.92	10.69
Spikes, per linear foot ..... do	2.30	1.28	.84
Staples, per linear foot ..... do	.13	.04	.05
Cost, per linear foot	$20.07	$27.08	$27.86

This gives the average cost of the three works per linear foot as $28. To this should be added cost of repairing during the season, interest, deterioration of plant, superintendence, surveys, and other expenses, as per following estimate:

Repairs of plant for 12 months		$50,000.00
Value of plant June 1, 1892	$169,391.00	
Forty G. S. barges, at $1,000	40,000.00	
Steamer *Vedette*	6,000.00	
	215,391.00	
Ten per cent of this total		21,539.10
For office expenses, surveys, etc		12,000.00
Total		83,539.10

The linear feet of work finished was:

Ashbrook Neck	2,610
Greenville Harbor	4,450
Louisiana Bend	5,835
Total	12,895

$83,539 \div 12,895 = \$6.48$ to be added, making total cost, say, $34.50 per linear foot.

Very respectfully,

ARTHUR HIDER,
Assistant Engineer in Charge.

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

REPORT OF MR. CHARLES H. MILLER, SUPERINTENDENT OF CONSTRUCTION, ASHBROOK NECK.

DELTA, LA., *January 30, 1893.*

SIR: The following gives in detail the cost and amount of labor and material used in the work at Ashbrook Neck. Work was commenced on September 15, 1892, and 2,610 linear feet of work was completed by January 7, 1893, and party disbanded, with exception of towboat crew and clerical force, the crew of the boat being kept to tow in "plant" and waiting for pay until the 11th of January, the clerical force and assistant in charge being transferred to Delta Point work on January 14.

The following facts are to be considered in comparing the work just finished with that of the previous season at the same place:

First. The excessive cost per foot of the hand grading was due to an extraordinarily bad bank—one filled with large cypress stumps. An ordinarily bad bank would not cost over half as much. The excess was 75 cents per linear foot.

Second. The number of squares of bank slope paved this season for 2,610 linear feet of work was 75 squares in excess of the number laid last season for 4,460 feet of this work. This was due to the fact that the work this season was all done at low water, giving a very wide slope to be paved (104 feet), about the same amount of stone being used both seasons (3.2 cubic yards per square). We have 1.48 yards excess per linear foot this season, giving, at $2.07 per yard, $3.06 per foot.

Third. Delay at the end of the season because of no stone.

From November 15 to December 12, 1892 (on which latter date the stone was about exhausted), we received an average of one barge per day, counting Sundays and two rainy days. After December 12 there was needed to complete the work ten barges of stone, and if received at rate of one per day (throwing out the 16th and 19th, rainy days) we could have finished by December 24. Work was finished fourteen days later.

Expenses.

Steamer *Vedette*	$40
Superintendence, cooks, etc	40
Board, 40 men	20
Total	100

Fourteen days, at $100 = $1,400 for 2,610 feet of work, gives an average excessive cost of 53 cents per foot.

Fourth. The charges for towage were above the actual necessities of the work. These deductions would bring the cost of the work per foot to $25, a figure within which, under ordinary circumstances, the work could be done. A tracing of Ashbrook Neck map, showing entire work done each season, bar line for 1891 and 1892, and position of breakwaters has been prepared, blue prints from which accompany this report.

Very respectfully,

CHAS. H. MILLER,
Superintendent Construction.

Mr. ARTHUR HIDER,
U. S. Assistant Engineer.

Statement of cost of work done, 1892–'93.

Kind of work.	Cost per unit.	Labor cost per unit.	Material cost per unit.	Material expended.	Time list expended (total).	Subsistence expended (total).	Total cost of work.
Mat work (6,688 squares)	$3.99	$1.356	$2.63	$17,620.52	$6,956.59	$2,110.06	$26,687.17
Hydraulic grading (2,500 linear feet)	1.17	.842	.325	811.45	1,857.17	248.74	2,917.36
Hand grading (2,500 linear feet)	1.503	1.445	.058	145.75	2,121.35		
Team hire					848.00	643.43	3,758.53
Revetment (1,089 squares)	7.476	2.346	5.131	5,586.87	1,960.45	594.62	8,141.94
Shore connections (115 squares)	14.62	7.354	7.265	835.46	649.10	196.59	1,681.15
Clearing (10.2 acres)	54.999	54.00			422.61	128.18	550.79
Paving slope	7.841	1.233	6.605				
Driver, 500 squares		1.423		29.25	547.56	134.81	
Hand, 2,310 squares		1.208		18,530.58	2,141.39	649.51	22,033.10
Towing				2,586.19	3,884.96	894.74	7,365.89
Sundries, office and traveling expenses							1,026.55
One-half value of property purchased							1,723.10
Total cost of work done, 2,610 linear feet, at $29.075 per foot							75,885.58
Building breakwaters					173.24	52.24	224.48
Repairs to old work				1,088.69	449.73	136.41	1,674.83
Total expended				47,234.76	22,011.15	5,789.53	77,784.89
Stone loaded (14,955.7 cubic yards)	.3414				5,531.75	70.35	5,602.10

Percentage of cost.

	Per cent.	Amount.
Material, supplies, property, etc.	59.67	$45,282.98
Subsistence	6.20	4,705.94
Towing	9.71	7,365.89
Office and traveling expenses	1.35	1,026.55
Superintendence	3.08	2,338.87
Labor	19.99	15,165.35
Total	100.00	75,885.58

WORK DONE.

2,610 linear feet of mat built and bank slope paved, at $29.075 per linear foot, total cost of same $75,885.58

Subdivided as follows:

Mat work:

6,688 squares mat built, at $3.99		26,687.17
34,371 hours' labor, at 20.24 cents	$6,956.59	
34,371 hours' subsistence, at 6.139 cents	2,110.06	
	9,066.65	
4,164 cords brush	3,670.17	
911.3 cords poles	1,312.27	
4,636 cubic yards stone	9,605.51	
26,750 pounds wire cable	1,306.27	
56,135 pounds wire	1,573.47	
5,200 pounds spikes	122.18	
325 pounds staples	30.65	
	17,620.52	

NOTE.—The cost of labor and subsistence per hour was found by dividing net time list ($15,647.20)—towage and loading stone having been deducted—and subsistence $4,714.53) by total hours of labor applied to work (76,799), giving $20.24 for labor and 6.139 as subsistence average.

Mat work—Continued.		
Labor, cost per square	$1.356	
Material, cost per square	2.63	
Hour's labor, per square	5.14	
Laying and ballasting revetment:		
1,089 squares revetment built and laid, at $7.476		$8,141
9,686 hours' labor, at 20.24 cents	$1,960.45	
9,686 hours' subsistence, at 6.139 cents	594.62	
	2,555.07	
899 cords brush	800.11	
130 cords poles	187.20	
2,645 pounds wire	75.02	
350 pounds spikes	8.02	
2,178 cubic yards stone, at $2.0737	4,516.42	
	5,586.87	
Labor, cost per square	2.346	
Material, cost per square	5.131	
Hour's labor per square	8.95	
Building and ballasting shore connections:		
115 squares, at $14.62		1,68
3,207 hours' labor, at 20.24 cents	$649.10	
3,207 hours' subsistence, at 6.139 cents	196.59	
	845.69	
222 cords brush	197.58	
30 cords poles	43.20	
267 cubic yards stone, at $2.0737	553.68	
280 pounds cable (wire)	13.47	
250 pounds spikes	5.72	
1,120 pounds wire, No. 12	21.81	
	835.46	
Labor, cost per square	7.354	
Material, cost per square	7.265	
Hour's labor, per square	28	
Clearing bank:		
10.2 acres, at $54		55
2,088 hours, at 20.24 cents	$422.61	
2,088 hours' subsistence, at 6.139 cents	128.18	
Paving slope:		
2,610 squares bank slope paved, at $7.841		22,03
2,196 hours' labor (driver)	$547.56	
2,196 hours' subsistence (driver)	134.87	
10,580 hours' labor (hand)	2,141.39	
10,580 hours' subsistence (hand)	649.51	
	3,473.27	
360 bushels coal, at $0.0975	29.25	
8,936 cubic yards stone, at $2.0737	18,530.58	
	18,559.83	
Labor cost, 500 squares, each (driver)	$1.423	
Labor cost, 2,310 squares, each (hand)	1.208	
Material, cost, 2,810 squares	6.605	
Hours' labor, per square (driver)	4.392	
Hours' labor, per square (hand)	3.03	
Hydraulic grading:		
2,500 linear feet bank graded, at $1.117		2,91
Labor, as per time list	$1,857.17	
Subsistence	248.74	
4,525 bushels coal	601.81	

Hydraulic grading—Continued.

247.5 gallons oils, etc		$161.16
30 pounds waste		3.00
10 pounds graphite		2.00
51 pounds cotton rope		6.12
25 yards duck		2.75
225 feet wire and insulators		12.21
56 pounds packing		22.40
		811.46
Labor, cost per linear foot		.842
Material, cost per linear foot		.325

Graders employed 43 working days.
Single-crew graders employed 15 working days.
Double-crew graders employed 28 working days.
Average cost per day, single crew, 8 hours, $44.
Average cost per day, double crew, 16 hours, $82.76.

Dressing grade (by hand):			
2,500 linear feet of grade dressed, at $1.503			$3,758.63
10,481 hours' labor, at 20.24 cents		$2,121.35	
10,481 hours' subsistence, at 6.131 cents		643.43	
212 days' team hire, at $4		848.00	
		3,612.78	
175 detonation, caps		1.75	
600 pounds dynamite		102.00	
100 pounds powder		10.00	
400 feet fuse		32.00	
		145.75	
Labor, cost per linear foot		1.445	
Material, cost per linear foot		.058	
Hour's labor, per linear foot		4.19	
Towing:			
Total expenses of steamers *Osceola* and *Vedette*			7,365.89
Steamer *Osceola*:			
Time list		$1,543.49	
Subsistence		353.28	
9,427 bushels coal	$1,395.34		
50 carbons	1.25		
1 cad matches	.45		
2 pounds drop black	.40		
4 globe valves	1.90		
5 pounds plumbago	1.00		
14 pounds asbestos	7.70		
10 pounds candles	1.10		
		1,408.24	
Total cost of *Osceola*		3,305.01	
Steamer *Vedette*:			
Time list		2,341.47	
Subsistence		541.46	
		2,882.93	
11,472 bushels coal	$1,069.78		
(Included in same item)	.09		
159 gallons oils, etc	72.11		
3 dozen wicks	1.65		
10 pounds waste	1.00		
34 lamps and lantern globes	8.45		
241 yards crash	19.74		
41 pounds cotton rope	5.13		
		1,177.95	
Total cost of *Vedette*		4,060.88	

Steamer *Osceola* (double crew) in commission 42 days, average (running steadily, heavy towing from Cairo)		$78.69
Steamer *Vedette* (single) 69 days, average (harbor work)		36.02
Steamer *Vedette* (double crew) 33 days, average (harbor and shore work).		47.75
Sundries expended and traveling expenses		1,026.55
One-half value of property purchased		1,723.10
Total expended on main work		75,785.58
Building breakwaters:		
851 hours' labor, at 20.24 cents	$172.24	
851 hours' subsistence, at 6.139 cents	52.24	
		224.48
Repairs to old work:		
2,222 hours' labor, at 20.24 cents	449.73	
2,222 hours' subsistence	136.41	
525 cubic yards stone	1,888.69	
		1,674.83
Total amount expended		77,684.89

REPORT OF MR. LUTHER Y. KERR, SUPERINTENDENT OF CONSTRUCTION, GREENVILLE HARBOR.

GREENVILLE, MISS., *March 2, 1893.*

SIR: The following report of Greenville Harbor improvement, giving the amount and description of work done, the quantity and cost of material, labor, etc., is respectfully submitted:

Description.—The plan of the work, as proposed at the beginning of the season, was to put in 4,500 linear feet of revetment immediately above last season's work, the bank to be graded down to a slope of 1 on 4.

A continuous line of willow mattresses made and sunk with shore connection of brush revetment securely fastened to the inside edge of the mat and extending up the slope to an elevation of 3 feet above the water on a falling river and 5 feet on a rising river. The shore mat and graded bank to be covered from the water's edge to the two-thirds stage, or about 30 feet on the Greenville gauge, with a stone paving 10 inches thick. The plan was slightly modified during the progress of the work, as will hereinafter appear.

Work began October 4, 1892, and closed February 11, 1893, with 4,450 linear feet of work completed during the season.

Hydraulic grading was begun October 5, 1892, and discontinued December 10, with 4,450 linear feet graded. Grader No. 1 arrived from Louisiana Bend and began work on October 6, using one 4-inch hose with a 1¾-inch nozzle; pump pressure, 150 pounds; steam, 80 pounds. A double crew was employed, working sixteen hours per day, during the entire service of fifty-eight days (Sundays excepted), in which time 3,240 linear feet were graded, an average of 55½ feet per day. Grader No. 3 arrived from Ashbrook Neck on November 6, and began work on the 7th, using one 4-inch hose with a 1¾-inch nozzle; pump pressure, 140 pounds, and steam, 80 pounds per square inch. A double crew was also employed on No. 3, working sixteen hours per day for twenty-nine days (Sundays excepted), grading 1,210 linear feet, an average of 42 feet per day.

The bank before grading was about 39 feet high, composed of clean sand and gumbo lying in strata varying in thickness and relative positions. This caused considerable gullying and caving, especially when the gumbo was found at the top with a stratum of sand beneath. The consequence of this was that when the grader had passed over the work it was left in a very rough and unfinished condition, badly cut up with gullies and by caving, which had to be dressed by means of shovels and drag scrapers. The cost of grading by the hydraulic graders was $1.55 per linear foot; the dressing, 65 cents per linear foot; total cost of finished slope, $2.20 per linear foot.

Mat building.—The construction of mats, on the same plan as followed at this place during the season 1891–'92, was begun October 26 and completed February 9, 1893. Eight mats, all 300 feet wide and varying in length from 165 to 1,120 feet, were made and sunk. One pocket mat, 160 by 110 feet, was made and sunk at the head of the old work, where a part of mat No. 1 (1891–'92) had been broken in order

to make a good connection. The dimensions of the mats and the order of building are as follows:

	Linear feet.
Mat No. 1	970 by 300
Mat No. 2	1,120 by 300
Mat No. 3	310 by 300
Mat No. 4	640 by 300
Mat No. 5	340 by 300
Pocket mat	160 by 110
Mat No. 6	415 by 300
Mat No. 7	343 by 300
Mat No. 8	165 by 300
Total	4,463

Mat No. 1 was begun about 3,300 feet above the head of the old work, and it was intended to cover this distance with three mats. Mats Nos. 1 and 2 were built and sunk between October 19 and December 3, 1892. Of this time seventeen working days were lost to mat-building for want of brush and poles. This expensive delay was caused partly by the inadequate towing facilities, but principally by the failure of the contractor to furnish the material as rapidly as needed.

Mat No. 3 which, to close the gap between new and old work would have been something over 1,200 feet long, was begun December 5, 1892, and by the 18th of that month had been built 1,127 feet. The river was rising rapidly and it became apparent that further delay in order to complete the mat would be dangerous, and preparations to sink it were begun at once, but delayed by the heavy rains until December 21, when the sinking was attempted. About 300 feet was submerged, the head lowered to the bottom and released from the mooring barges, when they, owing to the rapid current (over 4 miles an hour), and the immense amount of heavy drift brought down by the sudden rise in the Arkansas River, which had accumulated under and above the barges, parted the headlines one after the other and swung around, releasing the entire mass of drift. This drift, floating down, became entangled with the inclined portion of the mat, which was at an angle of about 45 degrees, parting it 310 feet below the head. Eight hundred and ten feet of mat was carried down the river and grounded on the bar just above Warfield's Towhead, from whence it was subsequently towed to Louisiana Bend and successfully sunk just above the mouth of Old River.

Mat No. 6 had to be sunk, on account of running ice, before it was completed the full length, leaving a small space between it and No. 1, which necessitated the building of mat No. 8.

The amount of brush used per square of mat built was 0.71 cords; of poles, 0.13 cords; total brush and poles 0.84 cords. Stone used in ballasting and sinking, 0.63 cubic yards. Total cost per square of completed mat was $3.876.

Shore work.—A shore connection was begun according to instructions and carried along with the mattress construction. Seven hundred and fifty linear feet of this work was built in front of mat No. 1, when, on the inspection of the Commission it was discontinued, and afterwards restricted to the water's edge.

Brush used per square of this work, 0.63 cords; poles, 0.11; total brush and poles, 0.74 cords.

The slope from low water to the 30-foot stage was covered with a stone paving 10 inches thick, carefully and closely laid by hand. The greater part of the stone was deposited on the slope by wheelbarrows, wheeling it up only far enough each time to make the work rapid and economical, keeping the slope well paved to a safe distance above the water. A steam pile-driver with traveler was used for a time to distribute stone on the upper slope. The comparative cost of the driver and barrows, while the driver was in service, was, driver, $1.57 per square; barrows, $0.57 per square. At the time when the comparison was made the circumstances were more favorable for the barrows than at any other time during the season's work, and the cost was below the average for that work, which was $0.76 per square. With the driver considerable time was lost in damp or rainy weather for want of friction between the drum and hoisting falls. If pile-drivers are to be used for this purpose in the future I would respectfully suggest that they be provided with larger drums, constructed of wood, and both drums and falls protected from the weather.

The stone used per square was 3.03 cubic yards; total cost of labor and material, complete, $7.69 per square.

Some damage was done the slope by the heavy rains during the latter part of the season, which was repaired by removing the stone from the washes, regrading the slope, and repaving with spawls to a depth of from 10 to 14 inches. The amount of brush, poles, and stone used per linear foot of completed work was—brush, 2.55 cords; poles, 0.35 cords; stone, 5.74 cubic yards. Total cost per linear foot of completed

work, $27.08, including the cost of the lost mat. Deducting the cost of that part of t mat lost (810 feet), the cost per linear foot would be $25.19.

Material.—Brush and poles were furnished by contract on barges, delivered at t contractor's camp and towed by the United States service, the average distance towing being about 160 miles. Stone was obtained by contract, delivered at Gree ville, Miss., on barges, to the amount of 27,627 cubic yards; 18,092 cubic yards we loaded on barges by contract from the surplus stone at Greenville; 1,959 cubic yar were reloaded from the surplus unloaded on the slope at the close of last season work. This reloading was done at odd times to keep the force employed. A gre deal of it had to be dug out, having been covered by a deposit during the last hig water. The expense of loading was 53 cents per cubic yard.

Soundings.—A series of soundings was made along the entire work on ranges 1 feet apart before and after grading the bank and after sinking the mat. Soundin were taken along the old work also, and compared with the sections of last seaso The result of the observations are shown by the plotted comparative sections.

Repairs to old work.—Considerable repairs were made to the old work during th season. Deep gullies had been cut in the slope during heavy rains by the surfa water flowing down the slope, undermining the riprap. To repair these wash the stone was removed from the washes and stripped back from the sides, the sid sloped off, and the whole repaved with small stone to a depth of from 10 to inches.

The cost of repairs made was $3,470.39. The larger part of this amount w expended in September in putting the old work in good shape at that time, b other repairs had to be made to some extent later in the season. To avoid th trouble with the surface water on the new work, the principal natural drains we opened out down the slope, and carefully paved to a depth of from 10 to 14 inch with small stone. The items and percentages of cost of the work done this seaso are as follows:

	Cost.	Per ce
Materials and supplies	$71,898.17	57.
Labor	32,212.57	26.
Towage	9,815.19	7.
Subsistence	5,884.31	4.
Superintendence	3,525.00	2.
Office and traveling expenses	663.44	.
Total	123,998.68	100.

Very respectfully,

LUTHER Y. KERR,
Superintendent Construction.

Mr. ARTHUR HIDER,
U. S. Assistant Engineer.

Statement of cost of work done.

26,484 cubic yards stone		$50,514.9
11,366.9 cords brush		9,407.5
2,008.3 cords poles		2,782.8
93,362 pounds wire		2,360.9
66,432 pounds wire strand		2,311.5
800 pounds staples and clevises		37.9
Lumber		163.2
47,704 bushels coal		4,711.7
5,600 pounds spikes		132.2
Oils		286.7
		72,709.5
Labor pay roll	$40,147.23	
Subsistence	6,780.33	
		46,927.5
Miscellaneous material		361.
One-half value property purchased		2,104.
Drugs		120.
Traveling expenses		17.
Telephone rent		39.
Miscellaneous		1,717.
Total expended		123,998.

Work was begun October 5, 1892, and closed February 11, 1893, making—

Number of days	129
Lost, Sundays and other days	27
Number of working days	102
Hydraulic Grader No. 1 worked ..... days	57
Hydraulic Grader No. 3 worked ..... do	28
Total	85

Laborers employed.

Month.	General work, number of men.	Hydraulic grading, number of men.
October, 1892	1,690	434
November, 1892	5,155	913
December, 1892	5,771	333
January, 1893	5,334	.....
February, 1893	1,017	.....
Total	18,967	1,680

18,967 ÷ 102 = 186 men per day on general work.
1,680 ÷ 85 = 20 men per day on hydraulic graders.

An average of 206 men per day.

Labor statement.

Month.	General work.	Hydraulic grading.	Towing.	Total.
	Hours.	*Hours.*	*Hours.*	*Hours.*
September, 1892	4,180	.....	.....	4,180
October, 1892	19,103	5,310	.....	24,413
November, 1892	46,315	10,928	5,096	62,339
December, 1892	52,709	3,953	5,368	62,030
January, 1893	50,269	.....	4,904	55,173
February, 1893	11,405	.....	2,592	13,997
Total	183,981	20,191	17,960	222,132

Distribution of time.

Kind of work.	Hours applied.
Mattress work	111,352
Paving bank and revetment	43,882
Hydraulic grading	26,590
Dressing slope	14,034
Care of fleet	13,706
Loading stone	5,195
Repairing old work	7,443
Total	222,132

Pay rolls as per abstracts sent in, not including subsistence, $38,206.48 ÷ 222.132 = 17.2 cents per hour. Pay rolls $38,206.48 and subsistence $6,780.33 = $44,986.81. $44,986.81 ÷ 222,132 = 20.2 cents per hour.

Labor per unit statement.

	Hours applied.	Squares built.	Linear feet worked.	Cubic yards loaded.	Hou per u
Mattress work	120,489	16,057			
Paving bank and revetment	48,451	5,292			
Hydraulic grading	26,520		4,450		
Dressing slope	14,034		4,450		
Loading stone	5,195			1,959	

Kind of material.	Mattress work, 15,506 squares built.		Shore connection, 551 squares built.		Bank paved, 5 squares built	
	Quantity.	Per square.	Quantity.	Per square.	Quantity.	Pe squ
Brush, cords	11,019.8	$0.71	347.1	$0.63		
Poles, do	1,947.7	.13	60.6	.11		
Stone (on 13,076 squares sunk)	8,291.7	.63			16,034.8	
Stone (on 2,430 squares lost)	358.9	.23				
Wire, pounds	90,827	5.86	2,535	4.60		
Wire strand, do	66,432	4.28				
Spikes, do	5,600	.36				
Staples, do	200	.013				
Clevises, do	600	.038				

NOTE.—All time, as per time sheets, included in above statements of distribution and cost of

Material per linear foot of completed work.

Material.	Total quantity.	Per fo
Brush, cords	11,366.9	
Poles, do	2,008.3	
Stone, cubic yards	25,585	
Wire, pounds	93,362	
Wire strand, do	66,432	
Spikes, do	5,600	
Staples, do	200	

Labor per linear foot completed work.

For entire work, including hydraulic grading, towing, etc., 222,132 ÷ 4,450 = hours.

NOTE.—See "Labor per unit statement" for classified work.

Subsistence statement.

Total cost of stores consumed	$6,7
Total cost of serving	1,7
Total cost of subsistence served	8,5
Number of rations issued	2
Number of days' labor secured	2
Daily cost per ration, raw	
Daily cost per ration, served	
Daily cost per ration for each day's labor secured	

NOTE.—Two thousand nine hundred and twenty-five days' labor secured party not subsisted is not included in the above statement.

Tabulated unit statement of cost.

Kind of work.	Unit cost. Labor and subsistence.	Material.	Total.	Entire cost work done.
Mattress work	$1.519	$2.355	$3.876	$62,226.93
Paving bank and revetment	1.855	5.837	7.692	40,706.06
Grading and dressing slope	1.845	.743	2.588	9,784.10
Loading stone	.537	.....	.537	1,051.98
Pay rolls, etc., from Memphis office				3,658.47
Dikes, transportation, office expenses, etc				988.88
One-half value of property				2,101.87
Cost of completed work				120,528.29
Cost of repairs to old work:				
Materials				1,966.48
Labor and subsistence				1,503.91
Total cost of repairs				3,470.39
Entire cost of work done				123,998.68
4450 linear feet work completed	$120,528.29	÷ 4,450	$27.08 per linear foot.	
Deduct cost of lost mat	8,428 40			
	112,099.89	÷ 4,450	25.19 per linear foot.	

NOTE.—Cost of towing, $9,815.19, distributed in above statement.

List of materials on hand at close of work.

Wire, 3,360 pounds, at $2.49	$83.67
Wire strand, 15,520 pounds, at $3.49	541.65
Spikes, 12,000 pounds, at $2.29	274.80
Coal, 3,000 pounds, at 9¼ cents	292.50
Total	1,192.62

REPORT OF MR. GEORGE C. THOMAS, SUPERINTENDENT OF CONSTRUCTION, LOUISIANA BEND.

GREENVILLE, MISS, *February 16, 1894.*

SIR: The plan of the work as originally proposed was for a continuous line of submerged mats 300 feet wide, commencing at the foot of last season's work and extending downstream a distance of 7,500 feet, with a shore connection of brush revetment extending up the bank to an elevation of 3 feet above the water on a falling stream and to 5 feet above when the river was rising; this revetment and the slope above to a two-third stage, or to an elevation of 21 feet on the Lake Providence gauge, to be covered with a stone paving 10 inches thick; bank to be graded to a slope of 1 on 4. This plan was strictly adhered to in the construction of Mats Nos. 1, 2, and 3, but under instructions slightly modified as to the remainder of the work, brush revetment being restricted to the water line.

Work began September 3, 1892, and closed down on account of high water January 14, 1893, with 5,835 linear feet of work completed during the season.

Clearing.—The bank along the proposed work was covered by a heavy growth of timber; this was cleared back a distance of 200 feet from shore; work was done by contract and same completed September 20, 1892. A total of 38 acres was cleared, at a cost of $16.95 per acre.

A second contract was let on November 17 for the slashing of timber below this season's work, to prevent its caving in and forming an obstruction to future work in way of snags. This timber was slashed and cut into 20-foot lengths for a distance of 3,400 feet; width of clearing, 200 feet; amount cleared, 15.6 acres, at $50 per acre.

Grading.—Hydraulic grading commenced on September 3, 1892, and was completed on December 15, 1892, total amount graded being 7,000 feet. Grader No. 1 began work on September 3 with double crew and two lines of hose, one 2" inches and one 4 inches; nozzles, 1 inch and 1¼ inch, respectively; pump pressure, 160 pounds; steam, 90 pounds. Grader was continuously employed sixteen hours per day until October 4, when, owing to the danger attending its further progress by reason of snags, it was transferred to Greenville Harbor, having been in service twenty-seven days.

cutting during that time 4,205 linear feet of slope, with an average of 156 feet per day.

Grader No. 77, with a single crew and one line of 2½-inch hose with 1-inch nozzle, began work on September 17, and was in service until the completion of the grade, December 15. A second line of 2½-inch hose with five-eighth-inch nozzle was put on November 20, and was continued for the remainder of the work. Grader No. 77 was in service sixty-nine working days, one-fifth of which time was lost on account of necessary repairs to machinery. It graded during the season 2,795 feet of slope, with an average of 40 feet per day of eight hours. Pressure used was steam, 130 pounds; water, 150 pounds.

The bank (with the exception of 600 feet at the head of the work, which was pure sand) was composed of "gumbo," which cut rapidly and washed without a sign of gullying, and but for its constant sloughing, which was mainly due to the sipage of water through the bank from a pond or basin behind the work, but little extra work would have been required to complete the slope. A large ditch for the drainage of this pond was opened on December 9, followed by a total disappearance of sipe water along the slope, and no further sloughing occurred. I am convinced that had this ditch been opened at the beginning of the work the cost of slope dressing would have been materially lessened, and for the future protection of the work I would respectfully recommend a permanent system of drainage to prevent the accumulation of water behind it, by digging ditches 4 feet wide on bottom with slope of 4 feet to 1, the average length of which would be 350 feet, depth 5 feet; a wooden culvert of logs to be constructed in bed of ditch, with opening of 1½ by 2 feet, to prevent its being closed by deposit from overflow.

Mat construction.—Mattress construction began September 13, 1892, and was completed December 28, 1892; a total of six mats were built and sunk, varying in length from 830 feet to 1,187 feet; average lap, 20 feet; plan of construction the same as for previous season. Everything was favorable for the rapid construction of this work up to October 14, brush and poles being obtained within 2 miles of the work, with the supply at all times equal to the demand, but for the remainder of the season material was obtained from Island No. 97, 10 miles below the work, and for lack of sufficient towing facilities delays were numerous and costly.

No trouble was experienced in sinking any of these mats, though, owing to an accumulation of drift against the mooring barges over Mat No. 6, it was deemed advisable to put on an extra set of mooring lines and to strengthen the mat by putting in a series of five-eighth-inch wire cables, securely fastened to the mat's head and extending down the mat a distance of 100 feet, with a round turn over each line of poles forming the frame of the mat. This was done to prevent the tearing loose of the mat in the event of the drift coming under the mooring barges.

Below are given the numbers and dimensions of the mats constructed:

	Feet.
Mat No. 1	1,005 by 300
Mat No. 2	1,040 by 300
Mat No. 3	980 by 300
Mat No. 4	850 by 300
Mat No. 5	1,187 by 300
Mat No. 6	830 by 300
Total	linear feet.. 5,892

The amount of brush used per square was 0.73 of a cord; poles, 0.12; total brush and poles, 0.85 of a cord. Stone used per square in ballasting and sinking was 0.63 of a cubic yard. Cost complete, $3.739 per square.

Brush revetment was constructed as per instructions over Mats Nos. 1, 2, and 3 to an elevation of 5 feet above the stage of water at which the mats were built. This revetment consisted of a double line of brush laid crosswise between a top and bottom frame of poles securely wired together every 8 feet. This plan was slightly changed as per instructions for Mat No. 3, the double course extending only to the water edge, with a single course for the remaining distance.

For Mats Nos. 4, 5, and 6 the revetment extended only to the water line, as directed. A stone paving 10 inches thick was laid over the entire slope from low-water line to an elevation of 24 feet (Lake Providence gauge). This paving was closely laid by hand, strict attention being given to the filling in of all spaces to prevent damage from wave wash.

The stone was unloaded on slope by means of wheelbarrows and a steam pile-driver with "traveler," the comparative cost of which was:

	Per square.
Pile-driver	$1.344
Wheelbarrows	.788

During the heavy rains toward the close of the work considerable gullying was caused by the surface water along the slope at the head of the work, which was nearly all sand. These were thoroughly cleared of all loose material, regraded, and repaved to a depth of 18 inches with small stone.

A total of 7,079 squares of shore work was built during the season, including bank paving and the construction and paving of brush revetment. Brush used per square of revetment was 0.85 cords; poles, 0.17 cords; total brush and poles, 1.02 cords. Stone used per square of paving was 3.58 cubic yards. Total cost per square complete, $9.887. The amount of brush, stone, and poles per linear foot of completed work was: Brush, 2.62 cords; poles, 0.45 cords; stone, 6.25 cubic yards. Total cost per linear foot of completed work was $27.86.

Material.—Brush and poles were delivered by contract, two-fifths of the amount furnished being obtained 2 miles above the work, the remainder 40 miles below. The principal amount of stone used was obtained by contract, shipped from North Alabama by rail, and delivered on barges at Greenville, Miss. Nine thousand eight hundred and forty-three cubic yards of stone were delivered on barges up White River, towed to the work, and unloaded on the bank during high water. The cost of reloading this stone for use was $0.384 per cubic yard. I would respectfully suggest that in future where stone is to be unloaded on the bank at a high stage of water that it be deposited as nearly as possible in one body and as nearly the top of the bank as safety from caving will admit, so as to avoid the extra expense of a long wheel and the constant shifting of runs. The percentage of the different items was as follows:

	Total cost.	Per cent.
Material and supplies	$106,768.79	64.22
Towage	12,171.59	7.32
Labor	35,991.49	21.64
Subsistence	8,167.71	4.92
Office and traveling expenses	619.55	.37
Superintendence	2,530.00	1.55
Total	166,269.13	100.00

Repairs, old work.—Repairs to the amount of $3,713.36 were done on the last season's work, consisting principally of reballasting revetment at lower end of work. A system of brush dikes, extending from the top of the revetment to the main bank was ordered constructed to prevent scouring behind the work, but owing to the continued high stage of water only two of these dikes were built. An itemized statement accompanies this report, giving the labor, subsistence, and material cost of each class of work in detail.

In conclusion, I beg leave to thank Messrs. W. M. Kellar, receiver of material, Martin Christensen, foreman, and J. W. Webb, commissary, for their valuable assistance in the management of the work.

The amount and value of material expended was as follows:

37,952.3 cubic yards stone	$76,991.99	
15,338.9 cords brush	14,587.81	
2,622.5 cords poles	3,933.75	
117,760 pounds galvanized wire	3,558.23	
700 pounds wire strand (three eighths inch)	24.43	
62,416 pounds wire strand (five-eighths inch)	2,728.86	
4,900 pounds wire spikes	124.81	
300 pounds staples	8.97	
21,294 feet lumber	276.25	
46,009 bushels coal	5,240.64	
Dynamite, powder, etc	276.25	
1,460 gallons oils	302.17	
		$108,054.16
Labor pay roll	45,536.00	
Subsistence	9,086.96	
		54,622.96
Miscellaneous material		345.38
Transportation		103.90
Clearing bank		1,783.77
Drugs		175.55
Stationery		115.65
One half value of property		1,067.76
Total expended		166,269.13

Began work September 3, 1892; closed January 14, 1893.

Number of days.....
Lost Sundays and other days.....

Number of working days.....

Hydraulic grader No. 1 worked.....days.....
Hydraulic grader No. 77 worked.....do.....

Labor employed.

Month.	General work (men).	Hydraulic grading (men).
September	3,555	
October	7,012	
November	7,137	
December	7,352	
January	1,484	
Total	26,540	

26,540 ÷ 105 = 253 men per day.
967 ÷ 96 = 10 men per day.

An average of 263 men per day.

Labor statement.

Month.	Hours of labor.		
	General work.	Hydraulic grading.	Total.
September	33,962	5,922	
October	53,384	2,622	
November	70,617	2,440	
December	75,459	1,196	
January	20,540		
Total	243,962	12,180	

Total amount of pay rolls for labor, not including subsistence, $45,536.00 ÷ 256,142 = 17.8 cents p
hour.

Distribution of time.

Kind of work.	Hours applied.
Mattress	
Paving bank and revetment	
Loading stone	
Dressing slope	
Hydraulic grading	
Care of fleet	
Total	

Material used per unit of mat.

[17,676 squares of mat built.]

Material.	Total.	Per square.
Brush.....cords	2,903.5	
Poles.....do	2,120.0	
Stone (ballasting).....cubic yards	4,565.8	
Stone (sinking).....do	6,701.9	
Wire, galvanized.....pounds	99,229.0	
Wire strand, five-eighths inch.....do	62,416.0	
Spikes, wire.....do	4,900.0	
Staples.....do	300.0	

Material used per unit of revetment.

Material.		Total.	Per square.
Brush	cords	2,385.4	.85
Poles	do	497.5	.17
Stone	cubic yards	10,043.7	3.58
Wire, galvanized	pounds	18,273.0	6.50

Material used per unit of bank paved.

[4,274 squares paved.]

Material.		Total.	Per square.
Stone	cubic yards	15,336	3.58

Bank graded	linear feet	7,125	
Labor required	hours	12,800	=1.7 per linear foot.
Slope dressed	linear feet	5,835	
Labor required	hours	27,680	=4.75 per linear foot.
Stone loaded	cubic yards	9,843.1	
Labor required	hours	18,604	=1.9 per cubic yard.

Labor and material, per linear foot, completed work.

		Total.	Per linear foot.
Material.			
Brush	cords	15,288.9	2.62
Poles	do	2,617.5	.45
Stone	cubic yards	36,447.4	6.25
Wire, galvanized	pounds	117,502	20.14
Wire, strand (five-eighths inch)		62,416	10.69
Spikes, wire		4,900	.84
Staples		300	.05
Labor.			
Grading bank	hours	12,180	2.09
Main work	do	243,962	41.81

Subsistence.

Total amount expended		$9,086.96
Total cost of serving		2,245.15
Total cost, served		11,332.11
Number of rations issued		38,902
Number of days' labor secured		32,018
Daily cost per ration, served	cents	29.2
Daily cost per ration, raw	do	23.4
Daily cost for each day's labor secured	do	35.5

List of materials on hand.

11,884 pounds wire strand (five-eighths inch), at $4.81	$571.62	
9,017 pounds wire strand, at $3.49	314.70	
10,905 pounds galvanized wire (five-eighths inch), at $3.49	380.58	
14,950 pounds galvanized wire, at $2.79	417.10	
52,440 pounds galvanized wire, $2.49	1,305.03	
11,300 pounds spikes, at $2.29	258.77	
700 pounds staples, at $2.99	20.93	
		$3,268.73

CREDITS.

137 cords poles to Greenville Harbor	$205.50	
3,358 cords brush to same	328.01	
300 cubic yards stone to same	720.56	
2,816 bushels coal to Delta Point	274.56	
2,100 bushels coal to survey party	204.75	
Subsistence stores, survey party	86.27	
Subsistence stores, Delta Point	105.90	
Subsistence stores, care of fleet	666.33	
One-half value of property purchased	1,067.75	
Clearing bank below this work	780.50	
		$4,448
Total credits		7,708

Tabulated unit statement of cost.

Kind of work.	Unit cost.			Entire cost of work done
	Labor and subsistence.	Material.	Total.	
Mattress work.....squares..	$1.452	$2.287	$3.739	$66.08
Paving bank and revetment .....do....	1.676	8.214	9.887	70,02
Loading stone	.374	.01	.384	3,78
Grading and dressing bank, linear feet	1.003	.108	1.111	7,92
Clearing bank.....				1,73
Towing				12,17
Office expenditures.....				11
Transportation.....				18
Property, one-half value.....				1,08
Total cost work done.....				162,55
Cost of repairs to old work:				
Cost of material.....				3,11
Labor and subsistence				60
Total cost of repair work				3,71
Entire cost of season's work				166,26

5,835 linear feet work completed: $162,555.97 ÷ 5,835 linear feet = $27.86 per linear foot.

Very respectfully,

GEO. C. THOMAS,
Superintendent of Construction

MR. ARTHUR HIDER,
U. S. Assistant Engineer.

APPENDIX 5 B.

REPORT OF ASSISTANT ENGINEER H. ST. L. COPPÉE ON WORK AT VICKSBURG.

VICKSBURG, MISS., *April 30, 189*

SIR:

* * * * * * *

Vicksburg Harbor.—At the time of submitting the last annual report the dre*Herndon*, of the Alabama Dredging and Jetty Company, was working in the cana the extension of the original contract of 1891 (11.9 cents). The contract was comple and the final estimate submitted July 31, 1892. As soon as the dredge was remo from the canal careful cross sections throughout the entire harbor were sounded the fill and general change in form of slopes, etc., obtained, a report of which forwarded to office at Memphis, together with detailed drawings, map sections, The fill in canal and basin from September, 1891, to August, 1892, as estimated f the soundings, was 129,601 cubic yards situ measurement, equal to 150,340 cubic ya scow measurement. The dredging was carried on in such a manner as to obtai channel depth to the zero plane of the gauge, but this was not realized permanen as the sides of the cut slid in, reducing the level of the bottom to + 2 feet at fi and later to an average in canal of + 6 feet on gauge, the basin being considera deeper.

The theory of the subsidence of the sides of the excavation and cause of exces fill was submitted with my report, mentioned above, it being recommended slopes be cut and the dam at head of basin be completed in order to remedy th defects.

On July 22, 1892, I submitted to you, in accordance with instructions, a project for the further expenditure of $80,000 in the harbor. This project contemplated the use of the "Menge" dredge and a contractor's plant, the continued dredging of the canal and basin, and deposit of dumpage on dam at head of basin, and the constructing of a levee on said dam to level of De Soto Island.

The new contract was let October 1, 1892, to the Alabama Dredging and Jetty Company at 16 cents per cubic yard in scows, the increase in price being caused to a great extent by clause in specifications requiring dredges to keep channel open for navigation.

Work was commenced on this new contract January 30, 1893, your orders being to cut to the —5-foot plane, to dump no material on dam, and to cut perpendicularly, making no slopes. The work of dredging is progressing satisfactorily up to the present time, the material being placed in Lake Centennial, west of De Soto Island, at such points as will be beneficial if the Yazoo project for improvement of harbor is undertaken. An approximate survey of the canal and basin was made March 15, 1893, and from the soundings it was estimated that a fill had taken place amounting to 120,062 cubic yards (in situ) since August, 1892. This fill includes all the area within the limits of the top of changing bank on each side of excavation, and shows that there is a continuation of the increased accretion that has occurred in the last two years. The only way to check this abnormal fill (as stated in my former reports) is by building the dam at head of basin to cut off all inflowing currents that are laden with silt from the main river.

The dredging up to date in the harbor is as follows:

Excavation (scow measurement):	Cubic yards.
1888	324,941
1890	465,573
1891	331,204
1892	294,447
1893 (to April 30, inclusive)	156,918

In 1888 the price in situ was 18 cents (Alabama Dredging and Jetty Company).

In 1890 the price in scows was 10 and 12 cents (Alabama Dredging and Jetty Company).

In 1891–'92 the price in scows was 11.9 cents (Alabama Dredging and Jetty Company).

In 1893 the price in scows was 16 cents (Alabama Dredging and Jetty Company).

The 12 cents in 1890 was account long haul, which was never made. The plant now employed by the contractor is the same as last year.

The original intention of working the "Menge" dredge after repairs were made was abandoned, and she has been looked after and is held in reserve to use in case the contractor fails to carry out the present contract in accordance with the specifications. With the exception of a new roof covering put on October, 1892, no repairs have been made since last year's extensive overhauling of her.

Delta Point, Louisiana.—Last year the continued caving of the bank above the Delta wharf boat and the deterioration of the revetment below necessitated a more careful study of the changes in the river along the Delta Point reach. A survey was made, and maps and cross sections of bank submitted. A comparison of the lines and sections of former years with the results of the survey showed that the change in the Delta bank had been gradual and not very extensive since 1884. A deep hole had been scoured out by the confined low-water current in the vicinity of the upper end of revetted reach, threatening its stability. On January 18, 1893, taking advantage of low water and availability of organized party that had just completed work above Greenville, outfit was sent down to construct and sink a mattress in the deep hole, it being deemed expedient to postpone the upper bank work till another low-water season. A mattress 300 by 685 feet was made in the usual manner, but in sinking was torn from its fastenings and floated to the bar just below the Vicksburg, Shreveport and Pacific Railway transfer incline, where the sunken end lodged. The mattress was cut in two, and the end remaining intact towed up in the eddy about half a mile and sunk, it being impossible to get it to the desired point. A full report of this was submitted in February. The cost of the work was as follows, including towing from Greenville and return:

Subsistence	$1,636.69
Wire spikes, cable, coal, etc., from Greenville	2,871.92
Repairs, brush, stone, hardware, coal, etc., purchased	4,577.11
Time list, labor account	3,896.70
	12,782.42
Credit, material returned, deducted	2,289.91
Total cost of work	10,492.51

This gives cost per square of 100 square feet of $5.10, and per running foot of $15.32. Material per square and per running foot was as follows:

[Mattress 300 by 685 feet.]

Material.	Total amount.	Per foot.	Per square.
Wire cable.....pounds..	15,525	22.66	7.55
Wire No. 12.....do....	9,635	14.06	4.70
Spikes.....do....	1,700	2.48	.827
Brush.....C..	1,219	1.78	.59
Poles.....C..	292.8	0.427	.014
Stone.....cubic yards..	1,059.57	1.54	.575

Only part of the mattress was sunk, 374.1 cubic yards of rock received, not included in this, being unloaded in a pile on bank for further use. The outfit was returned to Greenville, Miss., and party disbanded about February 15, 1893.

From my report, submitted at close of this work, I quote as follows:

"The following modifications in the practice in mattress work are suggested to me by the present disaster: In the first place, the necessity for reënforcing the deadmen timber with iron where cable comes in contact with it, even when overlarge, to preclude any possibility of shearing; also the advisability of building heads every 200 feet across mat, so that in case of drift the mat can be cut and the lower part dropped downstream and sunk, or where it gets away it can be cut in 200-foot sections with heads of sufficient stiffness to sink."

As soon as the river drops to a medium low stage a careful examination and soundings should be made at Delta Point, in view of the probable necessity of further repairs and additions.

Yours, very respectfully,

H. ST. L. COPPÉE,
U. S. Assistant Engineer.

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

APPENDIX 5 C.

COMPARISON OF LOW-WATER SOUNDINGS TAKEN THROUGH LAKE PROVIDENCE REACH, 1882–1891, INCLUSIVE.

MEMPHIS, TENN., *November 2, 1892.*

SIR: I have the honor to invite your attention to the accompanying tables derived from the low-water surveys of Lake Providence Reach since 1882, and to certain deductions I make therefrom as to the effect of the works which have there been constructed upon the low-water channel.

These tables contain the following data computed from the maps for every section surveyed: First, the width at bank-full stage; second, the low-water width, taken at an arbitrary stage (minus 1.5 feet); third, the maximum depth on the section at the same stage; fourth, the mean depth; fifth, area of the section—these elements being computed both with and without chutes. These soundings were taken in the years 1882, 1883, 1881, 1886, 1888, 1890, and 1891.

I have also made the following subdivisions of the reach, and computed the means of the above data for the various sections: First, from Station 61 to 87, inclusive, which is opposite and below the dikes which are in existence; second, from Station 39 to 60, which includes the section of river in which dikes have been constructed and destroyed.

The portion of the reach above has been divided into three sections on account of the imperfections of the records, the early surveys only extending to Station 14. Between Stations 11 and 29 there is a further complication, due to the fact that in certain years soundings were only taken at the even stations. In making comparisons, therefore, I have only selected, through this section, the even stations to determine the mean shown on blue prints by a full line. The mean of all soundings is shown by a broken line.

Tables showing these means are also appended, and they are also graphically represented on the accompanying drawings.

It will be noted from these tables that there has been, first, a general increase in bank-full width; second, a marked increase in the widths at a 1.5 stage to 1888, with the exceptions of from Stations 61 to 87, while in 1891 all low-water widths show a diminution from those of 1890; third, the maximum depths have diminished (though not materially from Stations 40 to 87 until 1891); fourth, the mean depths have diminished, except between Stations 61 and 87; fifth, that areas appear to have increased until 1888, and since then diminished.

In other words, the large expenditure on Lake Providence Reach, and for levees in the third district, has been accompanied by a gradual increase in high and low water widths, and a diminution of maximum and mean depths, except between Stations 61 and 87, a distance of 26,000 feet, and the survey of 1891 gives grounds for apprehension that further deterioration may there occur. The reduction in areas as well as low-water widths in 1891 is also deserving of serious consideration, especially where accompanied by a reduction of mean and maximum depths.

Such injurious changes in the regimen of the river through this reach should be accompanied by a deterioration in the navigable channel. A direct comparison of the various crossings is impracticable on account of the extensive changes in their position during the last ten years.

In the following table the least depths on crossings reported since 1884 is given, derived from the annual reports to 1890:

Year.	Least depth on crossings.	Lake Providence gauge.	Year.	Least depth on crossings.	Lake Providence gauge.
	Feet.	*Feet.*		*Feet.*	*Feet.*
1884	11	5.8	1889	8.5	2.25
1885	13	9	1890	11	8.5
1886	8.5	5.3	1891	7	10
1887	7	4.5	1892	6	1.35
1888	9	9			

In investigating the causes of these changes of regimen, it has been noted that the results appear to be independent of the stage of water at which the surveys were made. (Hydrographs of Lake Providence are submitted for the various years with the dates of survey recorded upon them.) And that records of the rate of caving in the vicinity of Elton, as reported by the Louisiana board of engineers, indicate that in that section of the river caving has rapidly increased in recent years; from 1860 to 1882 being at the rate of 100 feet a year, and from 1882 to 1890 at the rate of 262 feet per year, and from 1890 to 1891 over 600 feet per year.

Observations have been made of the intensity and direction of the river currents during high and low water. Three stations were selected; one near the head of reach at Pilchers Point, a second at Wilsons Point, about the middle of the reach, and the third at Shipland. The accompanying blue prints show the results of the observations at Wilsons Point and Shipland.

The thread of maximum velocity during floods did not coincide with that during low water. At Louisiana Bend and Shipland the thread of maximum velocity during floods was on bars outside of the low-water channel. A continual variation in the locus of the maximum velocity at Wilsons Point during floods was also observed.

It is to be noted that on the crossings above Shipland in 1891 there was but 7 feet, with the Lake Providence gauge reading 10 feet, and in 1892 7 feet, with the Lake Providence gauge reading 7.5 feet.

The observed mean velocities during floods at Wilsons Point have also been plotted under hydrographs. There has been an increase in flood heights from 1882 to 1892 of 3.6 feet; the floods of 1890, 1891, and 1892 exceeding in height that of 1882.

The maximum and minimum gauge readings at Lake Providence Reach during the period from 1882 to 1892 are as follows:

Date.	High water.	Low water.	Date.	High water.	Low water.
1882	38.32	8.00	1888	38.10	5.50
1883	36.47	4.20	1889	29.40	2.80
1884	38.40	5.55	1890	41.00	8.50
1886	37.91	2.55	1891	41.1	0.6
1887	38.00	1.52	1892	41.9	.....

These observations appear to indicate, first, that while the closing of chutes and the diminishing the widths of the river by means of permeable dikes will temporarily improve its low-water channel, if the bank opposite be not protected from caving, the channel will gradually remove from their sphere of action; second, that the construction of levees in the third district has largely increased the force acting during high stages, but that it is very doubtful whether this increased force is being applied through Lake Providence Reach in such a manner as to produce work useful in improving its low-water channel; that the force acting has been increased during floods is shown, not only by the gauge heights recorded, but by the measured maximum discharges past the latitude of Lake Providence, which are as follows:

	Cubic feet per second.
1882	1,057,000
1890	1,288,000
1891	1,346,000
1892	1,433,000

The principal points of application of this increased force appear to be, first, the levees themselves, which it breaks when practicable; second, caving banks; third, bars beyond the reach of low water; while in some places it is applied in destroying the low-water channel of the preceding year and increasing the amount of sand that is necessary to be moved during the succeeding low water.

That levees can be constructed that will better direct the flood flow through Lake Providence Reach is possible; the advisability of such construction is questioned. A levee is primarily and principally intended to protect land from overflow; to utilize it for improving navigation would necessitate its location in the vicinity of the currents to be controlled, and render it liable to be breached by caving banks. Its normal function of protecting property is too important to expose it to such risks for the uncertain benefits to be derived from its influence on the navigable channel.

Levees will continue to be constructed, whether injurious or beneficial to navigation, and it becomes, therefore, a question of vital importance to prevent the forces acting during a flood stage from causing a further deterioration of the navigable channel at this locality.

Lake Providence Reach has been selected by the Commission for the application of its methods of river improvement. The country will reasonably expect, with the liberal appropriations of the last Congress, some practically beneficial results in the interests of navigation. Without a large portion of the appropriation which remains unallotted be applied to Lake Providence Reach, or there is some change in the physical conditions which have obtained during the last ten years, these expectations can not be realized.

The deductions made above are only intended to apply to the portion of the river surveyed. Data is insufficient to deduce a general law applicable to the whole river. It is deemed probable that where the threads of maximum velocity coincide during high and low water stages, the construction of levees has improved the low-water channel. I have, however, investigated the question whether the injurious effects noted in Lake Providence Reach might not be due to a deepening of the river above, which was gradually extending downward and causing a deposition in the reach.

It can be stated that from the limited records of the third district no evidence has been deduced that levees have improved the navigation at any locality between White River and Warrenton.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain of Engineers.

Gen. C. B. COMSTOCK,
Colonel of Engineers, U. S. A.,
President Mississippi River Commission.

Survey of November, 1888.—Sections of river from Range 5 to 13, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
5	3,630	44	56,400				4,850	3,630	56,400
6	2,440	43	58,100				4,460	2,440	58,100
7	2,320	43	57,400				3,930	2,320	57,400
8	2,310	36	54,000				3,260	2,310	54,000
9	3,660	44	76,400				4,280	3,660	76,400
10	2,400	65	54,700				4,060	2,400	54,700
11	1,850	61	56,800				4,200	1,850	56,800
12	2,110	61	66,500				10,000	2,110	66,500
13	7,790	45	128,600				8,300	7,790	128,600
Total	28,510	442	608,900				47,340	28,510	608,900
Mean area	67,655						67,655		
Mean width	3,168						3,168		
Mean depth	21.4						21.4		
Mean maximum depth	49.1						49.1		
Mean high-water width							5,260		

Survey of November and December, 1890.—Sections of river from Range 5 to 13, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
5	3,320	44	53,400				4,890	3,320	53,400
6	4,140	25	49,800				4,700	4,140	49,800
7	3,820	23	48,700				4,220	3,820	48,700
8	3,600	33	49,300				3,700	3,600	49,300
9	3,900	22	51,600				4,020	3,900	51,600
10	3,500	26	56,300				3,800	3,500	56,300
11	3,340	25	59,800				3,900	3,340	59,800
12	3,050	35	52,600				10,000	3,050	52,600
13	2,830	39	50,600				9,320	2,830	50,600
Total	31,500	272	472,100				48,550	31,500	472,100
Mean area	52,455						52,455		
Mean width	3,500						3,500		
Mean depth	15.0								
Mean maximum depth	50.2								
Mean high-water width							5,394		

Survey of October and November, 1891.—Sections of river from Range 5 to 13, inclusive, reduced to—1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.	Area.
5	1,900	51	59,200				5,040	1,900	59,200
6	2,350	35	49,700				4,850	2,350	49,700
7	2,700	30	44,500				4,400	2,700	44,500
8	2,850	23	41,000				3,800	2,850	41,000
9	3,550	22	40,000				4,200	3,550	40,000
10	2,850	39	48,500				3,800	2,850	48,500
11	2,800	47	51,900				3,900	2,800	51,800
12	2,890	37	56,200				10,000	2,890	56,200
13	2,600	35	44,600				9,300	2,600	44,600
Total	24,490	321	435,600				49,290	24,490	435,600
Mean area	48,400						48,400		
Mean width	2,721						2,721		
Mean depth	17.7								
Mean maximum depth	35.7								
Mean high-water width							5,477		

Survey of September, 1883.—Even sections of river from Range 14 to 28, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
14	4,100	55	120,200				4,200	4,100	120,200
16	2,100	74	88,500				4,270	2,100	88,500
18	1,600	102	75,000				4,100	1,600	75,000
20	1,680	85	71,200				4,670	1,680	71,200
22	1,600	64	66,800				5,900	1,600	66,800
24	2,000	62	65,100				3,930	2,000	65,100
26	3,150	27	51,500				3,960	3,150	51,500
28	1,700	32	28,400	630	18	7,600	4,620	2,330	36,000
Total	17,930	501	566,700	630	18	7,600	35,650	18,560	574,300
Mean area	70,838			7,600			71,788		
Mean width	2,241			630			2,320		
Mean depth	31.6			12.1			30.9		
Mean maximum depth	62.5			18			62.5		
Mean high-water width	52.8						4,456		

Survey of October, 1884.—Even sections of river from Range 14 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
14	4,160	42	126,000				4,250	4,160	126,000
16	2,200	78	96,400				4,600	2,200	96,400
18	1,600	93	81,000				4,600	1,600	81,000
20	1,460	81	57,800				5,120	1,460	57,800
22	1,900	68	69,000				6,200	1,900	69,000
24	2,490	54	74,300				5,400	2,490	74,300
26	3,100	33	76,700				4,100	3,100	76,700
28	2,400	39	43,600	200	20	1,200	4,700	2,600	44,800
Total	19,310	488	624,800	200	20	1,200	38,970	19,510	626,000
Mean area	78,100			1,200			78,250		
Mean width	2,414			200			2,439		
Mean depth	32.4			6			32.1		
Mean maximum depth	61			20			61.0		
Mean high-water width							4,871		

Survey of November, 1888.—Even sections of river from Range 14 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.	Area.
14	6,100	53	131,800				7,740	6,100	131,800
16	5,200	43	153,300				5,300	5,200	153,300
18	3,300	61	99,700				3,610	3,300	99,700
20	1,320	49	50,000				4,300	1,320	50,000
22	1,760	61	66,000				4,850	1,760	66,000
24	2,700	53	81,600				3,230	2,700	81,600
26	2,850	36	54,800				3,940	2,850	54,800
28	3,300	24	54,200				4,520	3,300	54,200
Total	26,530	380	691,400				37,490	26,530	691,400
Mean area		86,425						86,425	
Mean width		3,316						3,316	
Mean depth		26.1						26.1	
Mean maximum depth		47.5						47.5	
Mean high-water width								4,686	

Survey of November, 1888.—Sections of river from Range 14 to 28, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
14	6,100	53	131,800				7,740	6,100	131,800
15	5,700	52	135,800				6,450	5,700	135,800
16	5,200	43	153,300				5,300	5,200	153,300
18	3,300	61	99,700				3,610	3,300	99,700
20	1,320	49	50,000				4,300	1,320	50,000
21	1,450	56	51,700				4,300	1,450	51,700
22	1,769	61	66,000				4,850	1,760	66,000
23	1,920	60	65,900				3,300	1,920	65,900
24	2,700	53	81,600				3,230	2,700	81,600
25	3,000	47	65,500				3,620	3,000	65,500
26	2,850	36	54,800				3,940	2,850	54,800
28	3,300	24	54,200				4,520	3,300	54,200
Total	38,600	575	1,010,300				55,160	38,600	1,010,300
Mean area		84,192						84,192	
Mean width		3,217						3,217	
Mean depth		26.2						26.2	
Mean maximum depth		47.9						47.9	
Mean high-water width								4,397	

Survey of November and December, 1890.—Sections of river from Range 16 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
16	1,760	51	54,300	1,480	4	4,400	3,050	3,240	58,700
18	4,350	54	152,600				4,690	4,350	152,600
19	3,550	44	100,300				3,840	3,550	100,300
20	2,560	57	40,300				3,650	2,560	40,300
21	1,740	65	72,300				3,290	1,740	72,300
22	2,360	59	54,700				3,160	2,360	54,700
23	1,730	54	61,400				3,460	1,730	61,400
24	2,150	61	68,700				3,600	2,150	68,700
25	2,500	51	66,800				3,950	2,500	66,800
26	3,300	22	52,100				4,750	3,300	52,100
28	4,050	14	38,800				4,720	4,050	38,800
Total	30,050	532	762,800	1,480	4	4,400	47,160	31,530	706,700
Mean area			69,300			4,400			69,700
Mean width			2,732			1,480			2,866
Mean depth			25.4			3			24.3
Mean maximum depth			48.4			4			48.4
Mean high-water width									4,287

Survey of November and December, 1890.—Even sections of river from Range 16 to 28, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
16	1,760	51	54,300	1,480	4	4,400	3,050	3,240	58,700
18	4,350	54	152,600				4,690	4,350	152,600
20	2,560	57	40,300				3,650	2,560	40,300
22	2,360	59	54,700				3,160	2,360	54,700
24	2,150	61	68,700				3,600	2,150	68,700
26	3,300	22	52,100				4,750	3,300	52,100
28	4,050	14	38,800				4,720	4,050	38,800
Total	20,530	318	461,500	1,480	4	4,400	32,620	22,010	465,900
Mean area			65,929			4,400			66,557
Mean width			2,933			1,480			3,144
Mean depth			22.5			3.0			21.2
Mean maximum depth			45.4			4.0			45.4
Mean high-water width									4,660

Survey of October and November, 1891.—Sections of river from Range 15 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.	Area.
15	2,460	30	49,000				8,050	2,460	49,000
18	2,100	28	37,600	1,960	26	29,100	5,000	4,060	66,700
19	3,520	44	73,300				4,210	3,520	73,300
20	3,400	56	92,100				3,900	3,400	92,100
21	2,000	78	80,300				3,500	2,000	36,300
22	1,500	77	68,500				2,400	1,500	68,500
23	1,460	78	59,800				2,400	1,460	59,800
24	1,860	62	72,900				3,850	1,860	72,900
25	1,750	66	65,200				3,690	1,750	65,200
26	1,920	54	62,000				3,620	1,920	62,000
27	2,550	29	42,500				4,000	2,550	42,500
28	3,050	16	38,800				4,890	3,050	38,800
Total	27,570	618	748,000	1,960	26	29,100	49,510	29,530	777,100
Mean area			62,333			29,100			64,758
Mean width			2,298			1,960			2,461
Mean depth			27.1			14.8			26.3
Mean maximum depth			51.5			26			51.5
Mean high-water width									4,126

Survey of October and November, 1891.—Even sections of river from Range 18 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
18	2,100	28	37,600	1,960	26	29,100	5,000	4,060	66,700
20	3,400	56	92,100				3,900	3,400	92,100
22	1,500	77	68,500				2,400	1,500	68,500
24	1,860	62	72,900				3,850	1,860	72,900
26	1,920	54	62,000				3,620	1,920	62,000
28	3,050	16	38,800				4,890	3,050	38,800
Total	13,830	293	371,900	1,960	26	29,100	23,660	15,790	401,000
Mean area			61,983			29,100			66,833
Mean width			2,305			1,960			2,632
Mean depth			26.9			14.8			25.4
Mean maximum depth			48.8			26			48.8
Mean high-water width									3,943

Survey of September, 1883.—Sections of river from Range 30 to39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	1,700	35	33,900	700	15	7,200	4,280	2,400	41,100
31	1,300	37	26,500	640	30	12,200	4,000	1,940	38,700
32	1,300	41	25,100	900	30	14,000	4,120	2,200	39,100
33	1,450	33	30,000	1,130	27	20,000	4,480	2,580	50,000
34	1,780	26	29,000	1,400	33	18,000	5,100	3,180	47,000
35	1,500	27	18,600	940	29	19,000	5,550	2,440	37,600
36	1,800	17	19,600	1,680	23	22,400	5,620	3,480	42,000
37	2,730	35	43,600	.....	.....	.....	5,580	2,730	43,600
38	1,420	36	32,200	.....	.....	.....	5,680	1,420	32,200
39	2,000	35	46,400	.....	.....	.....	5,900	2,000	46,400
Total	16,980	322	304,900	7,390	187	112,800	50,310	24,370	417,700
Mean area			30,490			16,114			41,770
Mean width			1,698			1,055			2,437
Mean depth			17.9			15.3			17.1
Mean maximum depth			32.2			26.7			33.7
Mean high-water width			.....			.....			5,031

Survey of October, 1882.—Sections of river survey from Range 30 to 39, inclusive, reduced to —1.5 Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.	Area.
30	800	42	20,800	1,400	32	22,500	4,200	2,200	43,300
31	725	39	22,800	1,400	29	22,100	3,790	2,125	44,900
32	1,200	44	38,600	1,200	22	15,000	4,100	2,400	53,600
33	1,525	39	30,000	1,100	15	10,000	4,490	2,625	40,000
34	2,100	52	35,600	.....	.....	.....	5,100	2,100	35,600
35	2,160	37	31,500	.....	.....	.....	5,600	2,160	31,500
36	2,600	42	47,400	.....	.....	.....	5,630	2,600	47,400
37	2,200	28	37,500	.....	.....	.....	5,650	2,200	37,500
38	2,400	20	36,100	.....	.....	.....	5,700	2,400	36,100
39	2,900	17	36,000	.....	.....	.....	5,980	2,900	36,000
Total	18,610	320	336,300	5,100	98	69,600	50,240	23,710	405,900
Mean area			33,630			17,400			40,590
Mean width			1,861			1,275			2,371
Mean depth			18.1			13.7			17.1
Meanmaximum depth			36.0			24.5			36
Mean high-water width			.....			.....			5,024

Survey of October, 1884.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	2,550	42	38,000	350	10	2,000	4,440	2,900	40,000
31	1,450	42	39,000	840	9	3,700	4,240	2,290	42,700
32	1,550	52	49,000	1,150	24	11,000	4,320	2,700	60,000
33	1,750	41	38,200	900	20	8,000	4,790	2,650	46,200
34	1,550	38	35,100	1,090	19	5,090	5,050	2,640	40,100
35	1,540	39	31,100	600	16	8,200	5,590	2,230	39,300
36	1,710	31	22,800	1,320	8	8,400	5,650	3,030	31,200
37	2,050	36	44,500	1,550	22	16,000	5,600	3,600	60,500
38	3,040	59	66,700				5,700	3,040	66,700
39	2,400	38	42,400				6,020	2,400	42,400
Total	19,590	418	406,800	7,890	128	62,300	51,400	27,480	469,100
Mean area		40,680			7,787			46,910	
Mean width		1,959			986			2,748	
Mean depth		20.8			7.9			17.1	
Mean maximum depth		41.8			16			41.8	
Mean high-water width								5,140	

Survey of November, 1888.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	4,880	18	47,400				4,880	4,880	47,400
31	2,350	29	36,200	700	20	8,800	4,760	3,050	45,000
32	2,520	37	45,100	1,800	19	11,000	5,400	4,320	56,100
33	2,050	46	45,400	1,100	18	12,700	6,430	3,150	58,100
34	1,220	36	37,400	1,150	14	9,400	6,940	2,370	46,800
35	1,640	41	37,800	900	23	10,400	7,050	2,540	48,200
36	3,800	40	59,400				6,450	3,800	59,400
37	2,340	38	37,600				5,820	2,340	37,600
38	2,960	40	52,500				5,550	2,960	52,500
39	4,250	25	74,900				5,850	4,250	74,900
Total	28,010	350	473,700	5,650	94	52,300	59,130	33,660	526,000
Mean area		47,370			10,460			52,600	
Mean width		2,801			1,130			3,366	
Mean depth		16.9			9.3			15.6	
Mean maximum depth		35			18.8			35.0	
Mean high-water width								5,913	

Survey of November and December, 1890.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum width.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	3,390	17	32,000	550	8	4,100	4,840	3,940	36,100
31	3,850	22	33,000	220	16	1,400	4,790	4,070	34,400
32	2,000	29	28,500	1,450	13	7,000	5,320	3,450	35,500
33	1,460	37	27,400	1,200	11	8,900	6,320	2,660	36,300
34	1,350	29	27,800	1,400	17	13,700	7,200	2,750	41,500
35	1,620	31	29,900	1,300	12	9,100	7,700	2,920	39,000
36	1,150	40	31,300	1,480	7	8,000	6,900	2,630	39,300
37	1,360	43	34,700	2,600	8	12,900	6,000	3,960	47,600
38	2,900	37	43,800	780	8	4,000	5,800	3,680	47,800
39	2,100	42	44,500	560	3	1,200	6,080	2,660	45,700
Total	21,180	327	332,900	11,540	103	70,300	60,950	32,720	403,200
Mean			33,290			7,030			40,320
Mean width			2,118			1,154			3,272
Mean depth			15.7			6.1			12.3
Mean maximum depth			32.7			10.3			32.7
Mean high water width									6,095

Survey of October and November, 1891.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	2,540	18	30,000	300	7	1,200	4,800	2,840	31,200
31	1,600	29	24,000	220	7	2,000	4,720	1,820	26,000
32	1,550	29	25,800	800	15	8,000	5,360	2,350	33,800
33	1,550	34	27,000	1,600	4	4,000	6,360	3,150	31,000
34	1,500	35	24,200	800	6	2,800	7,200	2,300	27,000
35	1,210	30	17,000	1,300	11	7,400	7,950	2,510	24,400
36	1,160	36	23,200	860	12	6,800	7,140	2,020	30,000
37	1,280	29	27,000	1,600	11	8,000	6,520	2,880	35,000
38	1,500	29	27,300	400	9	2,400	6,050	1,900	29,700
39	1,420	26	23,400	640	3.5	1,000	6,100	2,060	24,400
Total	15,310	295	248,900	8,520	85.5	43,600	62,200	23,830	292,500
Mean area			24,890			4,360			29,250
Mean width			1,531			852			2,383
Mean depth			16.3			5.1			12.3
Mean maximum depth			29.5			8.55			29.5
Mean high-water width									6,220

Survey of October, 1892.—Sections of river from Range 40 to 60, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	2,740	20	31,050				6,050	31,050	2,740
41	2,200	27	26,850				6,400	26,850	2,200
42	2,170	18	31,200				7,050	31,200	2,170
43	2,270	25	34,050				7,300	34,050	2,270
44	1,980	24	31,200	1,320	37	31,200	4,380	62,400	3,300
45	2,580	54	53,550				3,250	53,550	2,580
46	2,790	43	52,200				3,570	52,200	2,790
47	2,970	30	52,500				4,100	52,500	2,970
48	3,130	22	46,200				4,500	46,200	3,130
49	2,800	25	38,250				5,290	38,250	2,800
50	2,680	20	37,500				6,130	37,500	2,680
51	2,100	27	30,150				7,550	30,150	2,100
52	2,130	27	36,900				7,880	36,900	2,130
53	1,920	29	37,350				9,180	37,300	1,920
54	2,030	31	33,450				8,350	33,450	2,030
55	2,100	27	32,250				7,000	32,250	2,100
56	1,550	32	25,650				6,000	35,650	1,550
57	2,380	35	39,450				5,000	39,450	2,380
58	2,750	39	43,200				4,630	43,200	2,750
59	3,040	27	43,950				4,550	43,950	3,040
60	3,680	23	47,850				4,780	47,850	3,680
Total	51,990	605	804,750	1,320	37	31,200	122,940	845,900	53,310
Mean area			38,321			31,200			40,281
Mean width			2,476			1,320			2,539
Mean depth			15.5			23.6			15.9
Maximum depth			28.8			37			29.4
Maximum high-water width									5,854

Survey of September, 1883.—Sections of river from Range 40 to 60, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	2,200	30	45,200	450	7	2,000	6,140	47,200	2,650
41	2,320	31	47,200				6,400	47,200	2,320
42	2,640	32	49,900				7,050	49,900	2,640
43	2,940	36	52,000				7,180	52,000	2,940
44	4,200	35	70,000				4,440	70,000	4,200
45	2,050	63	55,500				3,310	55,500	2,050
46	2,160	45	60,500				3,510	60,500	2,160
47	2,560	37	60,400				3,940	60,400	2,560
48	3,050	25	51,700				4,430	51,700	3,050
49	3,450	20	26,400				5,200	26,400	3,450
50	3,030	16	26,000				6,290	26,000	3,030
51	2,580	20	25,000				7,500	25,000	2,580
52	2,210	18	24,500				8,000	24,500	2,210
53	1,250	39	29,400				9,160	29,400	1,250
54	1,600	41	48,500				8,150	48,500	1,600
55	1,710	47	45,600				7,150	45,600	1,710
56	1,570	38	40,000				5,700	40,000	1,570
57	1,980	51	58,200				5,100	58,200	1,980
58	2,480	48	61,200				4,620	61,200	2,480
59	2,750	40	67,200				4,450	67,200	2,750
60	3,350	28	50,800				4,805	50,800	3,350
Total	52,080	740	995,200	450	7	2,000	122,525	997,200	52,530
Mean area			47,390			2,000			47,486
Mean width			2,480			450			2,501
Mean depth			19.1			4.4			19
Mean maximum depth			35.2			7			35.2
Mean high-water width									5,834

Survey of October, 1884.—Sections of river from Range 40 to 60, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	1,220	40	38,000				6,180	38,000	1,220
41	1,260	49	47,000				6,380	47,000	1,260
42	1,950	49	56,400				7,120	56,400	1,950
43	2,350	36	56,900				7,110	56,900	2,350
44	3,990	26	70,200				4,260	70,200	3,990
45	3,320	55	58,200				3,440	58,200	3,320
46	3,400	47	55,400				3,560	55,400	3,400
47	3,700	45	49,500				4,000	49,500	3,700
48	2,880	43	40,500				4,580	40,500	2,880
49	1,430	50	47,000				5,300	47,000	1,430
50	2,110	39	46,000				6,250	46,000	2,110
51	2,730	45	37,200				7,500	37,200	2,730
52	2,900	47	42,000				8,730	42,000	2,900
53	2,800	29	35,300				9,200	35,300	2,800
54	2,440	37	31,200				8,340	31,200	2,440
55	2,580	22	28,300	350	5	2,000	7,050	30,300	2,530
56	2,000	32	33,900	640	5	2,400	5,980	36,300	2,640
57	1,780	24	29,800	600	6	2,000	5,030	31,800	2,380
58	1,280	45	29,400				4,720	29,400	1,280
59	1,380	56	44,700				4,650	44,700	1,380
60	1,780	46	60,000				4,790	60,000	1,780
Total	48,880	862	936,900	1,590	16	6,400	124,170	943,300	50,470
Mean area		44,614			2,133			44,919	
Mean width		2,328			530			2,403	
Mean depth		19.2			4			18.7	
Mean maximum depth		41			5.3			41	
Mean high-water width								5,913	

Survey of December, 1886, and January, 1887.—Sections of river from Range 40 to 60, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	3,770	17	62,250				6,180	62,250	3,770
41	2,610	31	38,400				6,560	38,400	2,610
42	2,395	56	40,650				7,300	40,650	2,395
43	1,800	47	35,550				7,000	35,550	1,800
44	1,780	45	45,750	380	5	2,100	4,370	47,850	2,160
45	1,810	37	45,450	400	13	3,000	3,500	48,450	2,210
46	3,640	29	48,000	160	6	1,200	3,550	49,200	3,800
47	3,585	20	45,450				3,820	45,450	3,585
48	3,920	39	37,200				4,500	37,200	3,920
49	3,410	42	42,000				5,440	42,000	3,410
50	2,560	54	40,200				6,520	40,200	2,563
51	620	48	28,500	670	10	5,250	7,530	33,750	1,290
52	1,680	30	27,300				8,380	27,300	1,680
53	2,675	24	42,000				9,250	42,000	2,675
54	1,790	49	51,750				8,520	51,750	1,790
55	1,720	37	40,650				7,130	40,650	1,720
56	2,510	23	37,800				5,800	37,800	2,510
57	2,610	20	35,700				5,130	35,700	2,610
58	2,900	22	39,450				4,750	39,450	2,900
59	3,110	25	35,400				4,680	35,480	3,110
60	2,930	23	37,500				4,900	37,500	2,930
Total	53,825	718	856,950	1,610	34	11,550	124,810	868,500	55,435
Mean area		40,807			2,887			41,357	
Mean width		2,563			402			2,639	
Mean depth		15.9			7.2			15.7	
Mean maximum depth		34.2			8.5			34.2	
Mean high-water width								5,943	

Survey of November, 1888.—Sections of river from Range 40 to 60, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	4,330	29	60,100				6,280	60,100	4,330
41	3,100	33	51,600				6,820	51,600	3,100
42	2,450	46	54,100				7,340	54,100	2,450
43	2,150	47	56,300				7,080	56,300	2,150
44	2,200	43	54,300				4,300	54,300	2,200
45	2,150	42	57,500				3,550	57,500	2,150
46	2,300	37	53,400				3,550	53,400	2,300
47	3,180	32	63,500				4,100	63,500	3,180
48	4,320	26	60,000				4,750	60,000	4,320
49	4,650	21	58,300				5,320	58,300	4,650
50	5,730	17	61,700				6,450	61,700	5,730
51	3,700	33	50,800				7,940	50,800	3,700
52	2,540	47	45,200	1,100	16	4,600	8,700	49,800	3,640
53	1,350	37	27,700	1,050	13	7,800	9,050	35,500	2,400
54	2,100	27	43,400	1,300	10	8,600	8,520	52,000	3,400
55	2,200	38	48,200	1,350	8	4,400	7,200	52,600	3,550
56	2,900	38	49,400				5,780	49,400	2,900
57	2,150	54	58,200				5,120	58,200	2,150
58	2,160	47	62,400				4,700	62,400	2,160
59	2,100	40	53,000				4,600	53,000	2,100
60	3,380	31	54,400				4,960	54,400	3,380
Total	61,140	765	1,123,500	4,800	47	25,400	126,110	1,148,900	65,940
Mean area	53,500			6,350			54,709		
Mean width	2,911			1,200			3,140		
Mean depth	18.4			5.3			17.4		
Mean maximum depth	36.4			11.7			36.4		
Mean high-water width							6,005		

Survey of November, 1890.—Section of river from Range 40 to 60, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	2,620	33	52,400	450	3	600	6,220	53,000	3,070
41	2,150	61	52,900	600	7	1,500	6,700	54,400	2,750
42	2,700	36	52,400	450	5	1,400	7,500	53,800	3,150
43	3,160	32	52,500				6,950	52,500	3,160
44	3,300	45	73,200				4,600	73,200	3,300
45	3,700	47	67,300				3,700	67,300	3,700
46	3,800	44	68,700				3,800	68,700	3,800
47	2,890	37	62,600	750	5	1,400	4,300	64,000	3,640
48	2,490	34	57,100	700	14	5,800	4,700	62,900	3,190
49	2,000	30	36,500	700	11	2,400	5,500	38,900	2,700
50	2,080	28	38,600	810	8	4,800	6,550	43,400	2,890
51	2,080	22	29,300	820	12	6,600	7,890	35,900	2,900
52	2,150	14	24,700	750	16	8,000	8,890	32,700	2,900
53	2,750	26	30,800	660	22	6,000	9,500	36,800	3,410
54	2,700	23	23,400	1,200	14	6,800	9,220	30,200	3,900
55	2,150	22	24,700	400	9	2,000	7,500	26,700	2,550
56	1,650	16	15,200	990	43	25,000	6,010	40,200	2,640
57	3,700	49	58,600	400	6	1,000	5,150	59,600	4,100
58	2,100	50	44,800	1,180	17	7,400	4,960	52,200	3,280
59	1,590	50	32,100	1,160	10	8,400	4,750	40,500	2,750
60	1,960	61	42,800				4,940	42,800	1,960
Total	53,720	760	940,600	12,020	202	89,100	129,330	1,029,700	65,740
Mean area	44,790			5,569			49,033		
Mean width	2,558			751			3,130		
Mean depth	17.5			7.4			15.7		
Mean maximum depth	36.2			12.6			37.6		
Mean high-water width							6,159		

Survey of 1891.—Sections of river from Range 40 to 60 inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	1,600	26	30,400	600	3	800	6,300	31,200	2,260
41	2,160	29	30,000	600	2	1,000	6,830	31,000	2,760
42	3,520	19	32,400	600	3	800	7,430	33,200	4,120
43	2,900	29	38,200	.....	.....	.....	7,020	38,200	2,900
44	3,000	25	43,200	.....	.....	.....	4,720	43,200	3,000
45	3,330	30	59,400	.....	.....	.....	3,710	59,400	3,330
46	3,120	42	62,400	.....	.....	.....	3,880	62,400	3,120
47	2,250	40	53,600	.....	.....	.....	4,350	53,600	2,250
48	1,810	39	45,800	.....	.....	.....	4,750	45,800	1,810
49	1,650	41	45,600	.....	.....	.....	5,580	45,600	1,650
50	1,840	42	40,000	.....	.....	.....	6,500	40,000	1,840
51	2,280	26	46,400	.....	.....	.....	7,940	46,400	2,280
52	2,550	23	40,000	.....	.....	.....	9,000	40,000	2,550
53	2,700	16	30,800	.....	.....	.....	9,600	30,800	2,700
54	2,380	15	22,600	.....	.....	.....	9,280	22,600	2,320
55	4,000	17	29,800	820	25	10,600	7,800	40,400	4,820
56	1,460	22	17,600	500	27	7,400	6,140	25,000	1,960
57	1,300	22	14,800	1,600	18	13,200	5,320	28,000	2,900
58	1,400	24	13,200	1,600	20	12,600	5,150	25,800	3,000
59	1,200	22	13,000	1,600	17	20,000	4,750	33,000	2,800
60	1,610	24	23,200	2,380	12	15,800	4,950	39,000	3,990
Total	48,000	573	732,400	10,360	128	82,200	131,000	814,600	58,360
Mean area		34,876			9,133			38,790	
Mean width		2,286			1,151			2,779	
Mean depth		15.3			7.9			14.0	
Mean maximum depth		27.3			14.2			27.9	
Mean high-water width								6,238	

Survey of October, 1882.—Sections of River from Range 61 to 87, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
61	3,100	46	52,350	.....	.....	.....	5,020	52,350	3,100
62	2,770	58	45,000	.....	.....	.....	5,210	45,000	2,770
63	1,170	54	41,700	340	25	5,700	5,280	47,400	1,510
64	1,100	65	38,400	500	16	6,450	4,920	44,850	1,600
65	1,280	61	45,600	300	25	4,050	4,950	49,650	1,580
66	1,480	57	52,950	660	26	11,700	5,100	64,650	2,140
67	2,220	56	59,100	900	20	10,350	5,450	69,450	3,120
68	2,450	28	42,000	.....	.....	.....	6,080	42,000	2,480
69	2,950	16	31,200	.....	.....	.....	7,500	31,200	2,950
70	4,300	15	33,750	300	16	2,100	8,290	35,850	4,600
71	3,020	16	30,300	420	27	6,150	8,000	36,450	3,440
72	1,080	20	14,850	1,930	16	28,950	7,090	43,800	3,010
73	1,300	61	9,750	1,530	16	42,000	7,220	21,750	2,830
74	870	48	9,600	1,800	18	24,800	7,310	34,400	2,670
75	780	44	8,250	1,830	19	34,650	6,750	42,900	2,610
76	1,660	37	12,450	1,120	15	16,000	6,420	28,450	2,780
77	1,880	29	12,450	1,380	16	17,450	6,050	29,900	3,260
78	1,740	32	22,500	1,200	47	22,650	4,920	45,150	2,940
79	1,050	26	22,200	1,440	59	33,000	4,550	55,200	2,490
80	1,360	18	21,750	1,700	59	57,150	4,750	78,900	3,060
81	1,830	16	16,800	1,720	51	37,200	5,250	54,000	3,550
82	2,800	51	50,400	.....	.....	.....	5,400	50,400	2,800
83	2,310	48	39,900	.....	.....	.....	5,710	39,900	2,310
84	1,500	74	29,850	.....	.....	.....	4,780	29,850	1,500
85	2,200	47	51,150	.....	.....	.....	5,000	51,150	2,200
86	2,420	38	43,950	.....	.....	.....	5,100	43,950	2,420
87	5,100	16	45,300	.....	.....	.....	5,350	45,300	5,100
Total	55,750	1,077	883,500	19,070	471	330,350	157,450	1,213,850	74,820
Mean area		32,722			19,432			44,950	
Mean width		2,065			1,122			2,771	
Mean depth		15.8			17.3			16.2	
Maximum depth		39.9			27.7			44.9	
Maximum high-water width								5,831	

y of September, 1883.—Sections of river from Range 61 to 87, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
	3,330	27	40,000				5,030	40,000	3,330
	2,680	39	36,200				5,480	36,200	2,680
	2,300	47	51,200				5,300	51,200	2,300
	2,250	59	47,200	460	19	5,400	5,000	52,600	2,710
	2,110	53	59,100	590	23	10,800	5,050	69,900	2,700
	1,810	52	47,500	700	8	2,300	5,150	49,800	2,510
	1,800	45	49,500	680	17	5,500	5,460	55,000	2,480
	1,660	45	49,600	650	15	7,000	6,110	56,600	2,310
	2,200	30	41,800	300	2	400	7,620	42,200	2,500
	2,200	22	31,500				8,400	31,500	2,200
	2,740	16	24,000	320	19	3,800	7,800	27,800	3,060
	4,000	13	30,000	750	14	5,400	7,150	35,400	4,750
	3,400	50	51,400				7,250	51,400	3,400
	2,660	20	41,000				7,500	41,000	2,660
	2,360	38	46,800				6,920	46,800	2,360
	2,200	33	40,000				6,100	40,000	2,200
	2,200	35	35,850				5,910	35,850	2,200
	950	33	40,200				5,000	40,200	950
	1,500	23	45,600				4,400	45,600	1,500
	1,560	20	20,000	850	57	32,000	4,800	52,000	2,410
	1,500	15	16,800	1,010	39	25,000	5,570	41,800	2,510
	2,110	12	14,000	960	39	22,700	5,320	36,700	3,070
	3,160	51	45,600				5,150	45,600	3,160
	1,550	64	40,000				4,760	40,000	1,550
	1,650	69	50,000				4,760	50,000	1,650
	1,580	57	47,000				5,100	47,000	1,580
	1,880	49	50,000				5,350	50,000	1,880
Total	59,340	1,017	1,091,850	7,270	252	120,300	157,440	1,212,150	66,610
area		40,435			10,936			44,894	
width		2,197			661			2,467	
depth		18.4			16.5			18.3	
maximum depth		37.7			22.9			41.1	
high-water width								5,831	

Survey of October, 1884.—Sections of river from Range 61 to 87, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
61	2,600	36	53,300	.....	.....	.....	5,100	53,300	2,600
62	3,090	19	40,500	.....	.....	.....	5,210	40,500	3,090
63	3,100	32	43,400	.....	.....	.....	5,400	43,400	3,100
64	2,230	56	26,000	150	8	1,200	5,000	27,200	2,380
65	2,050	51	33,000	500	24	8,400	5,080	41,400	2,550
66	1,780	50	42,000	650	13	6,000	5,240	48,000	2,430
67	1,840	49	40,600	700	12	5,600	5,550	46,200	2,540
68	1,390	53	43,800	350	8	1,400	6,090	45,200	1,740
69	1,750	41	43,000	350	6	1,300	7,050	44,300	2,100
70	2,050	36	44,800	.....	.....	.....	8,040	44,800	2,050
71	2,400	25	38,400	.....	.....	.....	8,020	38,400	2,400
72	2,400	29	40,800	.....	.....	.....	7,150	40,800	2,400
73	2,840	26	35,000	840	30	18,500	7,480	53,500	3,680
74	3,200	18	23,600	700	29	10,600	7,550	34,200	3,900
75	3,650	23	26,000	950	29	16,000	6,990	42,000	4,600
76	3,460	20	56,800	400	17	3,100	6,400	59,900	3,860
77	2,490	49	48,600	420	17	4,000	6,100	52,600	2,910
78	1,800	49	37,700	800	5	3,000	4,900	40,700	2,600
79	1,220	54	36,000	850	5	3,600	4,550	39,600	2,070
80	2,000	34	38,000	400	4	1,400	4,800	39,400	2,400
81	2,500	21	36,900	500	8	2,800	5,490	39,700	3,000
82	2,780	23	34,400	840	27	8,000	5,550	42,400	3,620
83	2,760	17	28,400	700	40	1,400	5,190	29,800	3,460
84	4,000	52	35,700	.....	.....	.....	4,800	35,700	4,000
85	3,700	49	33,400	.....	.....	.....	5,220	33,400	3,700
86	1,880	55	40,000	.....	.....	.....	5,780	40,000	1,880
87	1,540	58	52,000	.....	.....	.....	6,100	52,000	1,540
Total	66,500	1,025	1,052,100	10,100	282	96,300	159,830	1,148,400	76,600
Mean area			38,966			5,665		42,533	
Mean width			2,463			594		2,837	
Mean depth			15.8			9.53		14.9	
Mean maximum depth			37.9			16.6		39.7	
Mean high-water width			.....			.....		5,919	

cy of December, 1886, and January, 1887.—Sections of river from Range 61 to 87, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
.....	3,000	19	34,350	.....	.....	.....	5,100	34,350	3,000
.....	3,500	22	39,300	.....	.....	.....	5,350	39,300	3,500
.....	3,490	31	39,150	100	5	450	5,460	39,600	3,500
.....	3,260	47	38,100	280	5	1,200	5,100	39,300	3,540
.....	2,940	53	33,600	.....	.....	.....	5,190	33,600	2,940
.....	1,910	45	40,500	150	18	300	5,400	40,800	2,060
.....	1,760	44	45,900	500	19	1,650	5,680	47,550	2,260
.....	1,850	45	43,500	.....	.....	.....	6,260	43,500	1,850
.....	2,120	53	54,900	.....	.....	.....	7,600	54,900	2,120
.....	2,140	32	43,950	.....	.....	.....	8,400	43,950	2,140
.....	2,200	32	48,450	.....	.....	.....	8,020	48,450	2,200
.....	2,100	46	49,800	.....	.....	.....	7,800	49,800	2,100
.....	2,000	48	52,350	230	12	2,250	7,800	54,600	2,230
.....	2,300	40	52,050	380	21	4,950	7,530	57,000	2,680
.....	2,940	26	44,850	280	16	2,400	7,000	47,250	3,220
.....	3,960	16	42,000	450	3	900	6,550	42,900	4,410
.....	5,300	11	33,600	.....	.....	.....	6,100	33,600	5,300
.....	4,560	22	29,700	.....	.....	.....	5,400	29,700	4,560
.....	2,610	34	31,350	.....	.....	.....	5,250	31,350	2,610
.....	1,600	42	26,850	420	9	1,850	5,380	28,700	2,020
.....	1,400	38	31,200	650	10	2,580	5,920	34,050	2,050
.....	1,600	27	30,600	520	9	3,450	5,720	34,050	2,210
.....	1,890	28	29,850	620	10	3,300	5,410	33,150	2,510
.....	2,300	29	30,150	730	8	3,750	5,010	33,900	3,030
.....	1,460	22	29,850	700	7	2,400	5,370	32,250	2,160
.....	4,430	13	35,700	.....	.....	.....	5,960	35,700	4,430
.....	3,800	20	30,600	.....	.....	.....	7,000	30,600	3,800
Total.....	72,510	885	1,042,200	6,010	152	31,700	166,760	1,073,900	78,520
ı area.....			38,600			2,264			39,774
ı width.....			2,686			429			2,908
ı depth.....			14.4			5.3			13.7
ı maximum depth .			32.8			10.9			32.8
ı high-water width.									6,176

Survey of November, 1888.—Sections of river from Range 61 to 87, inclusive, reduc
—1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chute		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	W
61	3,740	26	58,400				5,160	58,400	
62	3,750	39	50,200				5,500	50,200	
63	3,500	52	45,100				5,560	45,100	
64	800	57	31,000	1,500	10	6,200	5,240	37,200	
65	1,150	57	51,400				5,300	51,400	
66	1,480	52	57,300				5,460	57,300	
67	1,620	55	54,400				5,800	54,400	
68	1,910	46	50,400				6,520	50,400	
69	1,700	38	48,100				7,840	48,100	
70	2,300	38	64,800				8,600	64,800	
71	2,000	37	46,300				8,380	46,300	
72	2,150	41	58,400				8,350	58,400	
73	2,400	38	55,700				8,620	55,700	
74	3,100	42	60,700				8,140	60,700	
75	2,120	45	40,100	300	10	1,200	7,360	41,300	
76	3,400	23	57,700	250	3	1,000	6,690	58,700	
77	4,000	17	53,000	500	13	3,600	6,400	56,600	
78	3,750	23	44,100	300	7	1,200	5,680	45,300	
79	4,400	21	38,600	400	25	6,600	5,450	45,200	
80	2,250	19	22,000	2,000	7	8,400	5,800	30,400	
81	2,200	26	23,000				6,650	23,000	
82	4,450	30	44,000				6,980	44,000	
83	3,200	32	40,000	900	16	5,000	6,750	45,000	
84	2,250	35	42,900	500	22	6,800	6,040	49,700	
85	1,550	38	38,300	600	7	800	5,490	39,100	
86	1,960	38	42,000				6,000	42,000	
87	3,140	31	47,600				7,060	47,600	
Total	70,270	906	1,265,500	7,250	120	40,800	176,760	1,306,300	
Mean area		46,870			4,080			48,381	
Mean width		2,603			725			2,871	
Mean depth		18			5.6			16.8	
Mean maximum depth		36.9			12			37	
Mean high-water width								6,547	

y of November, 1890.—Sections of river from Range 61 to 87, inclusive, reduced to — 1.5 on Lake Providence Gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
.....	1,700	36	42,400	.....	.....	.....	5,110	42,400	1,700
.....	2,380	25	46,900	.....	.....	.....	5,400	46,900	2,380
.....	3,400	21	46,400	.....	.....	.....	5,580	46,400	3,000
.....	3,300	19	46,500	.....	.....	.....	5,200	46,500	3,300
.....	3,050	45	45,800	.....	.....	.....	5,310	45,800	3,050
.....	2,360	46	48,200	.....	.....	.....	5,480	48,200	2,360
.....	2,200	39	48,000	.....	.....	.....	6,080	48,000	2,200
.....	600	60	38,200	.....	.....	.....	6,610	38,200	600
.....	1,810	58	52,800	.....	.....	.....	8,000	52,800	1,810
.....	2,020	43	53,300	.....	.....	.....	9,110	53,300	2,020
.....	2,080	45	54,800	.....	.....	.....	9,250	54,800	2,080
.....	2,110	42	56,900	.....	.....	.....	9,150	56,900	2,110
.....	2,010	45	58,600	.....	.....	.....	9,410	58,600	2,010
.....	2,420	57	71,600	.....	.....	.....	8,950	71,600	2,420
.....	2,900	50	65,500	220	10	1,400	8,050	66,900	3,120
.....	3,580	41	52,500	.....	.....	.....	6,900	52,500	3,580
.....	5,300	28	54,300	580	11	4,400	6,400	58,700	5,880
.....	3,700	29	32,100	400	16	2,400	5,650	34,500	4,100
.....	4,380	21	45,500	400	24	4,400	5,440	49,900	4,780
.....	3,500	25	29,200	1,300	4	3,600	5,720	32,800	4,800
.....	3,050	34	43,000	.....	.....	.....	6,700	43,000	3,050
.....	2,600	38	40,800	.....	.....	.....	7,100	40,800	2,600
.....	2,200	33	44,200	400	7	1,000	7,180	45,200	2,600
.....	2,450	28	45,400	300	3	400	6,900	45,800	2,750
.....	2,450	27	44,200	900	13	8,400	6,500	52,600	3,350
.....	2,400	25	44,100	900	7	4,400	6,350	48,500	3,360
.....	2,240	32	41,300	.....	.....	.....	7,000	41,300	2,240
Total.....	71,790	982	1,292,500	5,400	95	30,400	184,530	1,322,900	77,190
area.....		47,870			3,377			48,996	
width.....		2,659			600			2,859	
depth		18			5.6			17.1	
maximum depth..		36.3			10.5			36.5	
high-water width.	.....			.....				6,834	

Survey of 1891.—Sections of river from Range 61 to 87, inclusive, reduced to — 15 m Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width
61	1,000	33	25,800	1,800	2	2,800	5,140	28,600	2,88
62	1,090	39	29,000	400	4	1,600	5,440	30,600	1,48
63	1,760	33	37,200	750	3	1,400	5,530	38,600	2,51
64	1,750	30	37,600	220	8	1,600	5,210	39,200	1,85
65	3,160	25	43,000	.....	.....	.....	5,400	43,000	3,28
66	2,910	20	42,400	.....	.....	.....	5,440	42,400	2,70
67	2,660	19	38,000	.....	.....	.....	6,050	38,000	2,66
68	2,320	31	46,200	.....	.....	.....	6,680	46,200	2,28
69	1,990	37	42,400	.....	.....	.....	8,030	42,400	1,99
70	1,600	39	41,400	.....	.....	.....	9,100	41,400	1,68
71	1,380	43	44,000	.....	.....	.....	9,460	44,000	1,39
72	2,020	37	40,200	.....	.....	.....	9,720	40,200	2,02
73	2,510	38	57,400	.....	.....	.....	9,790	57,400	2,53
74	2,400	40	50,000	.....	.....	.....	9,280	50,000	2,40
75	2,500	36	58,600	.....	.....	.....	8,500	58,600	2,50
76	2,500	35	52,800	.....	.....	.....	7,430	52,800	2,58
77	2,390	32	55,400	.....	.....	.....	6,500	55,400	2,39
78	1,730	35	37,600	.....	.....	.....	5,660	37,600	1,73
79	2,040	19	33,000	.....	.....	.....	5,470	33,000	2,04
80	4,800	17	42,400	.....	.....	.....	5,730	42,400	4,80
81	4,520	22	45,200	.....	.....	.....	6,760	45,200	4,52
82	1,090	35	30,600	1,500	8	5,200	7,300	35,800	3,19
83	1,390	27	19,400	1,600	7	4,600	7,860	24,000	2,98
84	1,090	27	21,000	.....	.....	.....	7,790	21,000	1,09
85	1,130	20	19,000	.....	.....	.....	7,140	19,000	1,13
86	1,800	21	26,800	.....	.....	.....	7,390	26,800	1,80
87	1,900	20	23,400	.....	.....	.....	7,800	23,400	1,90
Total	58,030	810	1,039,800	6,270	32	17,200	191,480	1,057,000	64,20
Mean area			38,511			2,886			398,143
Mean width			2,149			1,045			2,381
Mean depth			17.9			2.7			16.4
Mean maximum depth			30			5.3			30
Mean high-water width									7,092

APPENDIX 5 D.

COST OF UNITED STATES LEVEES IN MISSISSIPPI, ARKANSAS, AND LOUISIANA.

Cost of levees in the Third District, built and enlarged by the United States, from 1882 t May 31, 1893.

MISSISSIPPI.

Year built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch to mile map.
1882-'92	Levee construction		2,651,774	$617,645.26	
1882-'92	High-water protection and engineering expenses.			120,669.72	
1892	From Station 2180 to 2638 and 2654 to 2700.	J. S. McTighe & Co	304,157	66,914.55	From 403 to 432.
1892	From Station 2800 to 2900	W. L. Withers	95,943	19,188.60	
1892	Station 2900 to 2962	John G. Sessions	66,867	13,039.06	
1892	Catfish Point	J. S. McTighe & Co	55,896	11,738.16	
1892	Station 2700 to 2800	Green Clay	95,226	19,997.46	
1892	Station 2148 to 2380	C. F. De Garis & Co	111,744	23,466.24	
1892	Station 3400 to 3500	Timothy Sullivan	63,532	13,182.89	
	Expended, high water protection and engineering expenses, May 31, 1892, to May 31, 1893.			14,643.72	
	Total to May 31, 1893		3,445,139	920,485.66	

of levees in the Third District, built and enlarged by the United States, from 1882 to May 31, 1893—Continued.

ARKANSAS.

Year built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch to mile map.
82-'92..	Levee construction		3,098,606	$660,143.37	
82-'92..	High-water protection and engineering expenses.			139,319.08	
892.....	Panther Forest	Arnold & Co	172,435	56,256.92	R. 451.
892.....	Lower Leland	Sterling Fort	10,982.5	2,196.50	R. 485.
892.....	Middle Place Loop	J. S. McTighe & Co	75,334.1	18,080.18	R. 430.
1892.....	Lakeport Crevasse	James S. Peak	6,941.5	1,093.28	R. 496.
1892.....	Brooks Mill Crevasse	do	64,895.7	9,444.84	R. 500.
1892.....	Upper Leland	Stripling & Wright	95,382.2	19,076.44	R. 469.
1892.....	Luna	Sullivan & Lewis	337,229.2	47,802.24	R. 468.
1892.....	Panther Forest (Station 1535 to station 1742).	Isaac M. Worthington	326,003.8	67,957.78	R. 452-453.
1892.....	Pastoria	C. F. DeGaris	28,186.3	6,482.85	R. 466.
1892.....	Lakeport	John C. Hodge	85,493.7	20,411.62	R. 467.
	Expended, high-water protection and engineering expenses, May 31, 1892, to May 31, 1893.			61,442.60	
	Total to May 31, 1893		4,301,490	1,100,707.70	

*$5,311.35 additional retained and unpaid May 31, 1893.

LOUISIANA.

1892-'93..	Levee construction		1,994,557.8	$443,016.27	
1892-'92..	High-water protection and engineering expenses.			120,278.57	
1892.....	(Millikens Bend to Cabin Teele) Station 0 to 31.	M. V. Henry	73,118	13,892.42	R. 581 to R. 584.
1892.....	Station 31 to 164	do	309,998.5	60,449.70	
1892.....	Station 164 to junction with levee, below Cabin Teele.	F. L. Maxwell	77,099.7	11,364.49	
	Expended, high-water protection and engineering expenses, May 31, 1892, to May 31, 1893.			12,929.35	
	Total to May 31, 1893		2,454,774	661,930.80	

APPENDIX 5 E.

STATEMENT, SUBMITTED BY MR. ARTHUR HIDER, UNITED STATES ASSISTANT ENGINEER, OF COST OF REPAIRS TO PLANT, THIRD DISTRICT, IMPROVING MISSISSIPPI RIVER, MAY 1, 1892, TO APRIL 30, 1893.

[Boats marked (*) have been docked, twenty-three in number.]

Steamer *Osceola**. General repairs; new cylinder timbers, new sides and new frames where necessary; new beams and new deck forward of engine; repairs to cabin, same painted; two sheets put in boilers, new breeching, machinery overhauled, new furnaces, and ordinary repairs during the season $5,135.3

Steamer *Meter*. New heaters, shafts welded, wheel rebuilt, new packing in engines, furnaces rebuilt, new fire pump, and painting and ordinary repairs during the season ..... 859.(

Steamer *Vidalia*.* General repairs; new sides and new frames where necessary; stern repaired, new rudders, new deck and beams forward of engines, new boiler deck outside of cabin, new crank pins, new bed plates and fastenings for cylinders, new breeching, three new sheets put in boilers, new fire pump, machinery overhauled, painting and ordinary repairs during the season 5,272

Steamer *Parker* (tug). Ordinary repairs; two new head sheets put in boilers, new breeching and ordinary repairs to hull and machinery during the season 93

Steamer *Etheridge*. General repairs; new deck forward of engines, repairs to guards, boiler deck, painting, new battery of boilers, new engine and dynamo, new breeching and fire pump, machinery overhauled, and ordinary repairs during the season $6,947.66

Steamer *Vedette*.* General repairs; new sides, stern and stem, new beams and deck forward of engines, new guards, new crank pins, new packing for cylinders, machinery repaired, pipe work in hold renewed, and ordinary repairs during the season 5,039.0

Grader No. 1. Ordinary repairs; machinery overhauled, new roof over after cabin, painting, and minor repairs during the season 704.2

Grader No. 3.* General repairs, sides and rakes rebuilt, new deck beams and deck, new roof over after cabin, machinery overhauled and repaired, new stack, painting, and ordinary repairs during the season 3,040.8

Grader No. 77. Ordinary repairs; new steam and water pipes, new coil in heater, new suction and siphon pipe, two auxiliary Hooker pumps set up, and minor repairs made during the season 237.4

Quarter boat No. 16. Ordinary repairs during season 42.3

Quarter boat No. 17. Same 4.7

Quarter boat No. 19. Same 6.1

Quarter boat No. 38.* General repairs; new gunwales and rakes, new floor timbers where necessary, and ordinary repairs during the season 641.2

Headquarters boat No. 31. General repairs to guards, deck, and cabin, calking above light water, and repairs to water pipes and boiler, and minor repairs during season 374.1

Quarter boat No. 34. General repairs to cabin to make ready for service. (Cabin now transferred to barge No. 87) 125.0

Quarter boat No. 33. Ordinary repairs to kitchen outfit. (Cabin now transferred to Barge No. 86) 16.0

Quarter boat No. 156.* General repairs; new gunwales, rakes, deck beams, and deck. Cabin of old quarter boat No. 22 transferred and fitted up inside. Kitchen outfit repaired 2,093.2

Quarter boat No. 157. General repairs to hull. Cabin of old quarter boat No. 21 transferred and fitted up inside, and kitchen outfit repaired 800.5

Quarter boat No. 155.* General repairs to hull. Cabin of old quarter boat No. 35 transferred and fitted up inside. Kitchen outfit repaired 922.7

Quarter boat No. 159.* General repairs; new gunwales, rakes, deck beams, floor timber, and bulkheads. Cabin of quarter boat No. 24 transferred and fitted up inside. Kitchen outfit repaired 2,477.7

Quarter boat No. 88.* General repairs, new gunwales, rakes, deck beams and deck. Cabin of old quarter boat No. 23 transferred and fitted up inside. Kitchen outfit repaired 2,384.5

Quarter boat No. 154.* General repairs. New bottom gunwales and rakes. Cabin of old quarter boat No. 37 transferred and fitted up inside. Kitchen outfit repaired 1,460.2

Quarter boat No. 36. Ordinary repairs made to cooking ranges and minor repairs to cabin. Cabin now transferred onto barge No. 158 ..... 73.7

Quarter boat No. 142 (the *Chester*) minor repairs 5.4

Quarter boat No. 86. General repairs to hull, etc. Cabin of old quarter boat No. 33 transferred and fitted up inside. Kitchen outfit repaired 721.9

Quarter boat No. 87.* General repairs to hull. Cabin of old quarter boat No. 34 transferred and fitted up inside. Kitchen outfit repaired 675.9

Quarter boat No. 158.* Cabin of quarter boat No. 36 moved on barge No. 158, now in dock having new bottom gunwales and rakes put in 350.3

Carpenter shop No. 78.* General repairs to hull; new guards, deck calked; old shop transferred and new shop fitted up with separate engine, boiler, and wood-working machinery 1,804.0

Machine shop No. 222.* General repairs to hull, new guards, calking, old shop and machinery transferred. Shop fitted up with separate engine and boiler. Machinery set in place 1,720.0

Property boat No. 85.* General repairs. Boat sunk in storm; boat raised; new bottom, gunwales, and rakes; decks calked and cabin repaired 856.1

Pile-driver, No. 31. Ordinary repairs; new stack, new flues put in boiler, furnace rebuilt 93.3

Pile-driver No. 32. Ordinary repairs; new pump set up, new flues put in boiler, furnace rebuilt 140.0

Pile-driver No. 33. Ordinary repairs during the season 32.8

Pile-driver No. 49. Ordinary repairs during the season 34.9

Pile-driver No. 34. Ordinary repairs; new flues put in boilers; furnace rebuilt 84.9

Pile-driver No. 54. Ordinary repairs; boilers and hoisting engine set up, new flues put in boiler, and furnace rebuilt 173.1

Model barge *Apache*. Ordinary repairs during the season, including calking above light water	$111.99
Model barge *Cheyenne*. Same	91.85
Model barge *Chinook*. Same	142.48
Model barge *Commanche*. Same	151.12
Model barge *Maricopa*.* Same. Also break in hull repaired	218.66
Model barge *Mohave*. General repairs; new deck, new frames, and calking above light water	485.59
Model barge *Piute*. Ordinary repairs during the season, including calking above light water	47.00
Model barge *Shoshone*. Same	68.82
Model barge *Uintah*.* General repairs; new frames, stems, side plank, deck calked, new kevils, and bitts	2,458.66
Mat boat No. 24. Ordinary repairs to put in service, including calking above light water	188.73
Mat boat No. 31. Same	131.23
Mat boat No. 30. Same	127.53
Mat boat No. 32. Same	117.69
Mat boat No. 33. Same	128.01
Mat boat No. 184. Same	20.09
Dump scow No. 1. Same	76.69
Dump scow No. 2. Same	105.52
Coal boat No. 139. Repairs to bottom	115.93
Fuel barge "E." Minor repairs	7.43
Fuel barge "A." Same	8.86
Fuel barge "F." Same	8.07
Barge No. 79.* General repairs, new gunwales, rakes, deck beams, and deck	1,774.93
Barge No. 80. Ordinary repairs	11.13
Barge No. 82. Same	29.83
Barge No. 83. Same	18.11
Barge No. 84. General repairs, new gunwales, rakes, deck beams, and deck	1,735.02
Barge No. 86. Ordinary repairs	19.77
Barge No 87.* General repairs, new gunwales, rakes, deck beams, and deck	1,817.20
Barge No. 106. Ordinary repairs	22.14
Barge No. 108. Same	9.68
Barge No. 111. Same	21.23
Barge No. 110. Same	10.80
Barge No. 135. Same	25.65
Barge No. 136. Same	74.15
Barge No. 137. Same	82.07
Barge No. 138. Same	63.26
Barge No. 530.* General repairs, new gunwales, bulkheads, rakes, and deck	1,267.34
Barge No. 534. Ordinary repairs	39.24
Barge No. 535. Same	57.79
Barge No. 539. Same	30.94
Barge No. 540. Same	37.01
Barge No. 541. Same	54.41
Barge No. 542. Same	28.90
Barge No. 543.* Same	95.66
Barge No. 545. Same	177.28
Barge No. 546. Same	71.41
Barge No. 547. Same	147.78
Barge No. 548. Same	51.38
Barge No. 549. Same	161.30
Barge No. 550. Same	31.26
Barge No. 45. Same	14.58
Barge No. 169. Same	3.30
Barge No. 204. Same	63.78
Barge No. 225. Same	66.15
Barge No. 544. Same	17.63
Tug dock. New stern dock built	256.18
Barge No. 230. Ordinary repairs	34.34
Barge No. 205. Same	125.56
Barge No. 212. Same	24.08
Barge No. 201. Same	32.10
Barge No. 207. Same	31.23
Barge No. 216. Same	14.46
Barge No. 217. Same	83.03
Barge No. 219. Same	60.94
Barge No. 214. Same	22.97

Barge No. 220. Same .....
Barge No. 210. Same .....
Barge No. 226. Same .....
Warehouse No. 2. Moving part of old machine shop on bank and blocking it up above high water for use as a shed .....

Total ..... 60,(

Approximate value of plant belonging to the United States and used upon the This trict, Mississippi River, May 31, 1893.

Class of property.	Pieces.	Approximate value.	Class of property.	Pieces.	A
Steamboats, etc.			*Steamboats, etc.*—Continued.		
Etheridge	1	$9,000	Machine shop with outfit	1	
Osceola	1	7,000	Floating dock	1	
Vidalia	1	6,000	Camel dock	1	
Vedette	1	4,000	Piled rivers and machinery	6	
Meter	1	3,000	Small scow	1	
Steam tug Parker	1	4,000	Yawls	7	
Mattress boats	5	6,000	Skiffs	54	
Headquarter boat	1	1,500	Tools and appliances	.....	
Quarter boats with outfit	12	7,200	Office furniture, safe, etc	.....	
Store boat	1	500	Dump scows	2	
Hydraulic graders	2	16,000	Surveying instruments	.....	
Hydraulic graders (small)	1	1,000	Dredge boat Menge	1	
Barges, model	10	15,000			
Square barges	90	85,000	Total value	.....	

List of civilian engineers employed on work of river and harbor improvement in cha Capt. C. McD. Townsend, Corps of Engineers, from June 1, 1892, to May 31, inclusive, under the river and harbor acts approved August 11, 1888, September 19, March 3, 1891, and July 13, 1892.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Work on which emplo
	Months.			
Arthur Hider, Greenville, Miss.	12	$250	Greenville, Miss	Care and repairs to plant vetmcht at Louisiana La., Ashbrook Neck, and Greenville, Miss.
E. C. Tollinger, Greenville, Miss.	12	175	Arkansas City, Ark	Construction and protect levees in Arkansas.
			Benoit, Miss	Construction and protect levees in Mississippi.
H. St. L. Coppée, Vicksburg, Miss.	12	175	Vicksburg, Miss	Dredging in Vicksburg bor.
John J. Hoopes, Arkansas City, Ark.	12	150	Arkansas City, Ark	Construction and protect levees in Arkansas.
J. D. Van Meter, Rosedale, Miss.	12	150	Benoit, Miss	Construction and protect levees in Mississippi.
			Arkansas City, Ark	Construction and protect levees in Arkansas.
W. S. Brown, Lake Providence, La.	12	150	Millikens Bend, La.; Lake Providence, La.	Construction and protect levees in Louisiana.

Abstract of proposals for levee work in Lower Yazoo levee district, received and open Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Station 2148 to 2380.	Station 2380 to 2480.	Station 2480 to 2550.	Station 2550 to 2638.	Stat 2654 to
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cen*
1	Sterling Fort	24	30	32	37	
5	Wm. R. Harvey	25	.....	.....	.....	.....
6	John G. Sessions	25	.....	.....	.....	.....
8	Johnson, McLaughlin & Sullivan	27½	27½	27½	27½	
9	P. F. Lamb	.....	25½	.....	.....	.....
11	C. F. DeGaris & Co	21	24	23	24½	
16	J. S. McTighe & Co	22	22	22	22	
17	Sullivan & Lewis	22	.....	.....	.....	.....

Abstract of proposals for levee work in Lower Yazoo levee district, etc.—Continued.

No.	Name of bidder.	Station 2700 to 2800.	Riverside, Station 2800 to 2900.	Land Side, Station 2800 to 2900.	Station 2900 to 2962.	Catfish Point Levee.
		Cents.	Cents.	Cents.	Cents.	Cents.
1	Sterling Fort	22	25	.....	30	49
2	Wm. L. Withers	.....	20	.....	22	.....
3	Green Clay	21	.....	.....	22	.....
5	Wm. R. Harvey	.....	.....	24	.....	24
6	John G. Sessions	22½	22	.....	19½	.....
8	Johnson, McLaughlin & Sullivan	27½	27½	27½	27½	27½
11	C. F. DeGaris & Co	22	21	.....	21	23
16	J. S. McTighe & Co	22	22	.....	22	21
17	Sullivan & Lewis	.....	.....	.....	.....	24
25	M. V. Henry	.....	.....	.....	.....	33
26	C. A. Winter	.....	25	24	24½	.....

Abstract of proposals for levee work in Upper Tensas levee district, received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Closing crevasses.				Closing crevasses and enlarging Upper Leland (R. 469).	Raising and enlarging Middle Place Loop (R. 430).
		Panther Forest (R. 431).	Lower Leland (R. 484).	Lakeport (R. 496).	Brooks Mill (R. 506).		
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1	Sterling Fort	59	*20	20	.....	21	38
4	Ernest Hyner	34	.....	.....	.....	.....	.....
7	Jeffries & Dameron	39	.....	22	19½	28	.....
8	Johnson, McLaughlin & Sullivan	37	.....	.....	25	.....	.....
9	P. F. Lamb	.....	.....	.....	22½	.....	.....
10	Scott & Russell	.....	.....	.....	17½	.....	.....
11	DeGaris & Arnold	.....	24	23	.....	24½	27
13	John McGuire	.....	.....	.....	19	.....	.....
16	J. S. McTighe & Co	34	22	21	25	21½	24
17	Sullivan & Lewis	.....	.....	.....	18	.....	.....
18	Whitehill Co	.....	.....	.....	.....	.....	25
20	Stripling & Wright	.....	20	.....	.....	20	.....
23	A. A. Arnold & Co	32½	.....	.....	24½	.....	.....
25	M. V. Henry	46	.....	30	24	31	35
27	I. M. Worthington	.....	.....	16	15½	23	.....
28	Jas. S. Peak	.....	.....	15½	13⅛	.....	.....
29	Isaac Henry & Co	.....	.....	25	20	.....	.....

* Contract awarded.

Abstract of proposals for levee work in Upper Tensas District received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Raising and enlarging Panther Forest Levee.			Constructing Luna Levee.			
		Station 1535 to 1599n (R. 449½).	Station 1599 to 1648 (R. 450).	Station 1681 to 1742 (R. 451).	Section 1 (R. 468).	Section 2 (R. 458).	Section 3 (R. 468).	Section 4 (R. 468).
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1	Sterling Fort	40	43	69	20	20	20	22
2	W. L. Withers	.....	.....	.....	21	19	21	.....
4	Ernest Hyner	.....	23	.....	.....	.....	.....	.....
5	William R. Harvey	.....	.....	28	.....	.....	20	20
7	Jeffries & Dameron	27	29	29	20	18	18	18
8	Johnson, McLaughlin & Sullivan	30	37	37	21½	21½	21½	21½
10	Scottt & Russell	22	.....	.....	17½	19½	19½	.....
13	Hartnett & O'Brien	.....	.....	.....	20	20	20	.....
14	O. B. Crittenden	21½	.....	24	.....	.....	.....	.....
16	J. S. McTighe & Co	29½	29½	29½	23	23	23	23
17	Sullivan & Lewis	21	.....	.....	15½	15½	15½	15½
19	Carlton & Bryan	.....	.....	.....	21½	19½	19½	19½
20	Stripling & Wright	.....	.....	.....	18	18	.....	.....
22	Ed. C. Manney	.....	.....	.....	17½	17½	.....	.....
23	A. A. Arnold & Co	24½	23½	22½	19½	19½	19½	18½
25	M. V. Henry	44	44	45	22	22	22	23
27	I. M. Worthington	20	22	21	16½	16	16	16
29	Isaac Henry & Co	.....	.....	.....	19	19	22	21

Abstract of proposals for levee work in Middle Tensas Levee District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Milliken Bend to Cabin Teele.			
		Station 0 to 31 (R. 581).	Station 31 to 82 (R. 582).	Station 82 to 164 (R. 583).	Station 164 to junction with levee below Cabin Teele (R. 584).
		Cents.	*Cents.*	*Cents.*	*Cents.*
7	Jeffries & Dameron	22	25	24	20
8	Johnson, McLaughlin & Sullivan	22½	23½	24	19
15	John Scott & Son	24	24	24	20
16	J. S. McTighe & Co	29	29	29	29
17	Sullivan & Lewis				17
21	F. L. Maxwell				14⅞
24	J. C. Hodge				17½
25	M. V. Henry	19	19½	19½	19
30	W. O. Flynn	23½	25½	22	18½
31	Dan. L. Hebron	22		23	17

Abstract of proposals for levee work in Upper Tensas District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, November 24, 1892.

No.	Name of bidder.	Pastoria (R. 466).	Lakeport (R. 496).
		Cents.	*Cents.*
1	Jeffries & Dameron	24	26
3	C. F. De Garis	23	24
4	Kilpatrick & Storer		27
7	J. C. Hodge		23½
8	Z. T. Carlton & Co	24	
10	Isaac Henry		25
11	Timothy Sullivan	25	

Abstract of proposals for levee work in Lower Yazoo Levee District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, November 24, 1892.

No.	Name of bidder.	Station 3400 to 3500.
		Cents.
3	C. F. DeGaris	21
5	W. E. Ringo	22½
6	C. A. Winter	22½
7	J. C. Hodge	22½
9	W. L. Withers	21
10	Isaac Henry	27
11	Timothy Sullivan	20½

Abstract of proposals for levee work in Lower Yazoo Levee District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 16, 1893.

No.	Name of bidder.	Above Greenville.							Below Greenville—Leota.
		Station 0 to 250.	Station 450 to 580.	Station 808 to 900.	Station 900 to 1080.	Station 1080 to 1200.	Station 1200 to 1300.	Station 1300 to 1423.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Jeffries & Dameron	26	19	23	35	25	20	24	18½
3	R. T. Martin	23	21	20½	39½	25	20	20	.....
4	John G. Sessions	.....	.....	.....	.....	.....	22½	21½	18½
6	Starling & Smith Co	19	20	19½	24	18	.....	.....	.....
7	McTighe & Co	22	23	20	29	27	20	21	17
8	P. F. Lamb	22½	20½	23	.....	21	.....	19½	.....
12	Robert Johnson	.....	.....	.....	.....	.....	.....	.....	23
13	T. J. Bogue	.....	.....	18 55/100	.....	.....	18 35/100	17 75/100	.....
14	W. L. Killebrew	27	20	28	31	27	19	24	19
19	Thomas Worthington & J. C. Nutt	.....	.....	.....	.....	.....	20	20	.....
22	John & Thomas O'Hearn	22½	32	28	28	28¾	19½	27½	.....
24	W. L. Withers & Co	22	18½	17½	23	18½	17⅛	17¼	.....
26	T. C. Ferguson	20¼	.....	.....	.....	.....	.....	.....	.....
27	Harvey & McGuire	20	20	22	40	22	20	19	18
30	Worthington, Nutt & Elkas	.....	.....	.....	.....	.....	.....	.....	18½
31	Merritt Williams	.....	.....	.....	.....	.....	.....	.....	14 19/100
34	Foley & McDonell	21½	19¼	.....	.....	.....	.....	.....	.....
35	McLaughlin Bros	23⅜	24	27	.....	.....	.....	24	.....
36	Tim Sullivan	.....	.....	18	19	19	18	18	17
40	J. A. Deaton & Co	22 55/100	22 55/100	22 55/100	24 50/100	25 55/100	22	22 48/100	16 55/100
41	Stansill & Clay	27	25	25	30	21 75/100	23	22½	.....
42	Arnold, De Garis & Co	19⅜	21⅜	24⅜	29⅜	24⅜	16⅜	18⅜	16⅜
46	J. B. Lewis	25	25	.....	.....	.....	.....	.....	16
47	Connor & Lester	21½	19	19	.....	.....	.....	.....	.....
52	Homan, McFadden & Cassidy	21 7/10	20 7/10	19 3/10	21	22 1/10	17 1/10	21 3/10	.....

Abstract of proposals for levee work in Upper Tensas Levee District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 16, 1893.

No.	Name of bidder.	Opossum Fork, Station 374 to 414.	Bellview, Station 95 to 127.	Pastoria, Station 127 to 164.	Dulaney Loop, Station 624 to 690.	Leland, Station 690 to 790.	Vancluse, Station 832 to 862.	Sunnyside to Lakeport, Station 1116 to 1216.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	C. A. Winter	.....	.....	27	17	23⅞	31	16½
2	Jeffries & Dameron	35	23	36	23	24	37	16½
4	Jno. G. Sessions	.....	19½	33½	21⅞	31½	.....	16½
5	Ed. D. Mantle	.....	.....	.....	.....	.....	.....	17⅞
6	Starling & Smith Co	*21	20	.....	.....	.....	.....	.....
7	McTighe & Co	24½	19	28	27	22½	42½	19
8	P. F. Lamb	.....	.....	.....	.....	25	37	.....
9	O. B. Crittenden	.....	16 95/100	.....	21	27	.....	.....
11	Chas. T. Worthington	.....	.....	.....	.....	.....	33	.....
13	T. J. Bogue	.....	19 55/100	.....	19 35/100	.....	.....	21
14	W. L. Killebrew	.....	25	27	23	21	30	19½
18	Jas. H. Cary	27	.....	27	.....	23	34	.....
22	John & Thomas O'Hearn	.....	21½	33¾	19½	28½	33	19½
24	W. L. Withers & Co	.....	.....	.....	18½	30	36	20½
25	Stripling & Wright	.....	32	40	21	33½	50	40
28	Will. H. Warner	.....	17	.....	.....	.....	.....	.....
29	Hartnett & O'Brien	.....	19	.....	20	.....	.....	19
35	McLaughlin Bros	.....	24	.....	17½	32	27	.....
37	M. V. Henry	33	27	35	33	43	43	27
38	Hebron, Hebron & Buck	.....	.....	.....	.....	20⅞	.....	.....
40	J. A. Deaton & Co	.....	22	23	18 45/100	21	34½	16½
42	Arnold, De Garis & Co	24⅜	15⅜	29⅜	16⅞	21⅞	39⅜	16⅜
43	Kilpatrick & Storer	.....	17	34	15 91/100	22	.....	.....
44	Manning & Gibson	.....	.....	.....	.....	.....	34	.....
45	Ernest Hyner	.....	.....	.....	* 15 94/100	18 94/100	42	13 44/100
46	J. B. Lewis	21½	22	40	23	24½	39	21
50	Carlton & Bryan	.....	18½	30	21	29	.....	.....
51	John C. Hodge	.....	.....	.....	16⅜	27½	35	24⅜
53	Whitehill Co	21	18½	20	17⅛	.....	.....	.....
54	Ben Talley	.....	24	23½	19	23½	.....	.....

* Contract made.

Abstract of proposals for levee work in Upper Tensas Levee District, etc.—Continued.

No.	Name of bidder.	Lakeport.		Below Lakeport,	Adams Front.		Kigers Loop.		
		Station 1216 to 1292.	Station 12+2 to 1368+66	station 40 to 105	Station 105 to 210.	Station 210 to 306.	Section 1, 50 stations.	Section 2, 30 stations.	Section 3, 23 stations.
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1	C. A. Winter	14	18	25	18	15	14⅜	14⅜	14⅜
2	Jeffries & Dameron	14	17	25	22	16	14⅜	15	17
4	John G. Sessions	14⅜	16⅞	24½	21½	17	15⅛	16⅛	16½
7	McTighe & Co	18	21	25	19	17	17	18	18½
8	P. F. Lamb						15⅞		
9	O. B. Crittenden	14 7/10	16	21	16⅛	16			
10	Michael McTighe						18	19	20
11	Charles T. Worthington						14½	14½	14½
12	Robert Johnson						15	15⅛	16
13	T. J. Bogue	20 88/100	19	19 44/100	18	17 94/100			
14	W. L. Killebrew	17	19	24	20	19	20	18	19
16	James M. Sullivan	12½			20½	18⅜	14½	15⅛	16
22	John and Thomas O'Hearn	16	21⅛	29⅛	34	34	15⅛	15⅛	16
24	W. L. Withers & Co	13	15	22	18	14⅛	16	15	17½
25	Stripling & Wright	16	18						
29	Harinut & O'Brien	15	21			18	15	16	18
32	James S. Peak	12	17½				12	15½	18½
33	Hebron, Hebron & Buck	18½	18½				16½	16	
35	McLaughlin Bros	17	19½		30	30	15	15	15
36	Tim Sullivan				18⅜	16⅜	13 88/100	13 88/100	13 88/100
37	M. V. Henry	27	27	33	33	33	17	17	17
38	Hebron, Hebron & Buck			20				16½	
40	J. A. Deaton & Co	15½	16⅛	24 88/100	18⅜	16⅛	16½	16⅛	16⅜
42	Arnold, DeGaris & Co	15⅜	16⅜	23⅜	15⅜	16⅜	15	15⅛	16
43	Kilpatrick & Storer				14 10/100	14 10/100			
44	Manning & Gibson						15	17	16½
45	Ernest Hyner	13 55/100	15 54/100	17 54/100	16 54/100	15 54/100			
46	J. B. Lewis	14⅛	*15	23	14⅛	14⅛	15⅛	16	17
48	Donovan & Daily	14 9/10					16 7/10	16 3/10	
51	John C. Hodge		19⅞	22⅛	23⅛	22⅞			
53	Whitehill Company					16			
54	Ben Talley						15⅛	15⅛	15⅛

* Contract awarded.

Abstract of proposals for levee work in Middle Tensas district, received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 16, 1893.

No.	Name of bidder.	Villa Vista Levee.			Salem Levee.	
		Upper section.	Middle section.	Lower section.	Upper section.	Lower section.
		Cents.	Cents.	Crnts.	Cents.	Cents.
1	C. A. Winter	15	24	22		
2	Jeffries & Dameron	15	21	20	17	15
4	John G. Sessions	18⅛	24½	21⅜	21⅜	17⅞
6	Starling & Smith Co				25	19
7	McTighe & Co	21	28	25	23	20
12	Robert Johnson	17⅛	18½	18	16½	18½
14	W. L. Killebrew	19	22	25	23	21
15	Robert Nicholson				29	14 88/100
16	Jas. M. Sullivan	15⅛				15⅛
17	Albert S. Colthorp			21 88/100		
20	F. L. Maxwell	17⅜				18⅜
21	Edmund T. White	28	28	25	22	22
23	Wm. J. McGinty	18				17
24	W. L. Withers & Co	15⅛	20½	*17	20	16½
35	McLaughlin Bros	16	19	19	19	16⅜
36	Tim Sullivan	15	24	22		
37	M. V. Henry	14 33/100	18 37/100	18⅜	19⅞	15
39	John Scott & Son	14 30/100	18 44/100	17 44/100	17 44/100	14 30/100
40	J. A. Deaton & Co	16⅛	19	17	19	19
42	Arnold, DeGaris & Co	19⅛	23	21⅛	22⅛	18
44	Manning & Gibson	15			16	14 88/100
46	J. B. Lewis	16	23	21	24	16
48	Donovan & Daily	19 3/10			19 3/10	18 3/10
49	J. Stein & Co	15 70/100	22 7/10			
51	John C. Hodge	15⅜	19⅜	19½	19⅞	15⅜

* Contract awarded.

Abstract of proposals for stone received and opened by Capt. C. McD. Townsend, Corps of Engineers, February 9, 1893.

No.	Name of bidder.	Place of delivery.	Price per cubic yard.
1	Judge C. Musgrove	Greenville, Miss	$1.79 8/10
2	Jas. A. Deaton & Co	do	1.80
		Arkansas City, Ark	1.90
		Little Red River, Arkansas	1.80
3	Alfred M. Julian & Co	Greenville, Miss	2.19
			2.21
4	Joseph Evans	White River, Arkansas; Little Red River, Arkansas	.54
5	J. B. & W. L. Killebrew	Greenville, Miss	*1.48 8/10
		Huntington, Miss	1.58 9/10
		Little Red River, Arkansas	*.49 8/10
		Yazoo River, Mississippi	1.54 9/10
6	W. E. Hunt & F. C. Dunn	Greenville, Miss	1.66
7	Carey & Shippey	do	1.85
8	Fred Hanger	Arkansas City, Ark	1.51
		Little Red River, Arkansas	.71
9	J. W. Worthington & Co	Greenville, Miss	1.67½
			1.72½
10	Jno. E. & Thos. P. O'Hearn	do	1.83½
		Little Red River, Arkansas	.61½
11	Edward Hely	do	.78
12	J. S. McTighe & J. C. McIntyre.	Greenville, Miss	1.88
		White River and tributaries, Arkansas	.82½
13	Alexander Montgomery	Between White River and Louisiana Bend	1.94
		Between Louisiana Bend and Warrenton, Miss	2.19
14	Green B. Greer & John Atkins.	Little Red River, Arkansas	.47
			.57
			.74
15	DeGaris & Arnold	Greenville, Miss	1.74
		Little Red River, Arkansas	.73
16	Homan, McFadden & Cassidy.	Arkansas City, Ark	2.28
17	Manoah V. Henry	Greenville, Miss	1.87
		do	1.83
		Arkansas City, Ark	1.97
		do	1.93
		Memphis, Tenn	2.17

*Accepted and contract made.

Abstract of proposals for two quarter boats, four mat barges, fifteen brush barges, yellow pine and oak lumber, received and opened by Capt. C. McD. Townsend, Corps of Engineers, March 10, 1893.

No.	Name of bidder.	Per quarter boat.	Per mat barge.	Per brush barge.	Per M feet, yellow pine.	Remarks.
1	Wiegel Bros	.....	.....	$3,175	.....	
2	M. A. Sweeny Co	$4,400	$4,980	3,200	.....	
3	Ed. J. Howard	5,650	5,350	3,250	.....	
4	S. M. Flesher	.....	.....	2,970	.....	Recommended for acceptance for 15 barges.
5	Woodward & Wight Co., limited.	.....	.....	.....	$28	Rough lumber, recommended for acceptance. Decking, recommended for acceptance.
					33	

No bid received for oak lumber.

APPENDIX 6.

REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1, 1893.

SIR: I have the honor to submit the following report upon works in charge of this office for the year ending May 31, 1893:

The office has charge of the Fourth district, Mississippi River, for the execution of works in accordance with the approved plans, specifications, and recommendations of the Mississippi River Commission. The district extends from Warrenton, 7½ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, and comprises 484 miles of the river.

The works under the Commission include improvements of the harbor of Natchez and Vidalia, Mississippi, and Louisiana; channel improvements at the junction of the Mississippi, Red, and Atchafalaya rivers near Turnbull Island, Louisiana; improvement of the harbor of New Orleans; the construction, repair and maintenance of a portion of the levee system of the district; the maintenance of certain gauges; and certain surveys, observations, and other special work.

HARBOR OF NATCHEZ AND VIDALIA.

The rapid caving of the bank in Giles Bend above Natchez has narrowed the adjacent neck so that there is danger that the river eventually will break through in high water and form a permanent cut-off. Should such cut-off take place it is apprehended that the river may change its course below by rapid erosion on the west bank, accompanied by accretion on the east bank. This would result in the destruction of a portion or all of the town of Vidalia and in injury to the water front and landings at Natchez. The object of the contemplated works is to delay and if possible prevent the formation of the threatened cut-off across Cowpen neck.

By the river and harbor act of July 13, 1892, an appropriation of $80,000 was made for this work.

On August 5 the Commission adopted the following resolution: "That in the opinion of the Commission the amount appropriated for the harbor at Natchez and Vidalia, Mississippi and Louisiana, is too small to justify beginning work at that place and they accordingly recommend that the funds be held in reserve until they shall be very largely increased by future appropriations."

On November 17, the following resolution was passed by the Commission:

"That it be recommended to the Secretary of War that the special appropriation for improving harbors of Natchez and Vidalia, or so much thereof as may be necessary, be expended in constructing a levee along the axis of Cowpen Point."

Upon recept of notice of approval of the above recommendation, preparations for the necessary surveys were made and the first survey was made in February, under direction of Assistant Engineer Douglas. A preliminary line was located, but this survey developed many features of the locality which, owing to the dense undergrowth on the neck, were previously unknown, and indicated that a more economical line might be found. Additional lines were therefore surveyed in April. A final location was adopted as the result of these surveys, and report and project for constructing the levee will be submitted before the next meeting of the Commission.

If the necessary right of way can be secured the levee will be built during the coming season.

Money statement.

Amount appropriated by act approved July 13, 1892	$80,000.00
May 31, 1893, amount expended during fiscal year	1,420.47
June 1, 1893, balance unexpended	78,579.53
Amount that can be profitably expended in fiscal year ending June 30, 1895	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Assistant Engineer H. S. Douglas reports as follows upon the surveys made under his direction:

NATCHEZ, MISS., *May 31, 1893.*

SIR: At date of last report no work was in progress and no funds were available. The caving of the river banks in the concave bends had progressed at a rapid rate and the high water of 1892 had developed a tendency to cut channels across the neck of land above Natchez.

The improvement desired consists principally in the maintenance of existing conditions in the river fronts of the cities of Natchez and Vidalia. These conditions are seriously threatened by rapid caving of the river banks in Giles and Marengo bends and a prospective cut-off through the narrow strip of land between Giles and Cowpen bends on the east bank of the Mississippi River immediately above Natchez.

The river and harbor act approved July 13, 1892, appropriated the sum of $80,000 for the commencement of the work in accordance with the plans of the Mississippi River Commission.

The estimated cost of the necessary plant required for the work of bank protection revetment was $65,000, leaving too small a sum available to justify the beginning of actual construction of this portion of the work.

It was considered that the most immediate danger to the harbors, and one that would be irreparable, was the threatened cut-off through the neck of land between Giles and Cowpen bends. The land forming the neck is not high and at a stage of 38 feet on the Natchez gauge the river begins to run across through small channels of recent formation. At extreme high water there is a depth of 10 feet through these channels. The fall across the neck during high stages of the river is over 3 feet, causing a very rapid current with a decided tendency to scour where the land is free from standing timber, underbrush, and accumulated driftwood.

The approved project contemplated the construction of a spur levee, commencing at the line of bluffs or high land and extending out on a line generally parallel to the axis of the point sufficiently far to prevent the flow of the water across the neck during flood stages of the river. It has been decided to undertake the building of this levee.

The work of the last season has consisted in making careful surveys of the point to determine the best location for the proposed spur levee consistent with economy of construction and reasonable permanence. The topography of the point is very rugged, being made up of a few narrow cleared ridges separated by wide sloughs covered with a dense growth of timber and underbrush. This entailed the running of a great many lines, as each one developed some new feature and suggested another line that might be better, the result of all being to give a very thorough knowledge of the locality. The surveys developed among other things that what may be termed the effective width of the neck is much less than heretofore supposed, as the lower side is only a flat mud bar which would be of no value in preventing a cut-off. The width of high land which constitutes the effective width is only about 2,800 feet. One of the lines crossed a former channel or old river bed, which is about 2,000 feet wide and would require a levee about 26 feet high where the line crossed. The traverse of the bank line, or the upper side of the neck, compared with that made in 1891 showed that caving was progressing at the rate of about 150 feet per year, the maximum recession of the bank from February, 1891, to January, 1893, being 325 feet. Eighteen pits were dug at different points on the neck to determine the character of underlaying strata. These pits were generally about 6 feet deep, at which depth in most cases water prevented going deeper. The information obtained was that the foundation of the levee would generally be on very recent river deposit, and that great care would have to be exercised in preparing the base.

Fifteen and one-half miles of alternative lines for a levee have been surveyed, 9 miles of bank line traversed to ascertain extent and amount of caving, and 6 miles of meander lines ran to locate topography. The field work has been platted and careful estimates of cubical contents of levees on different lines made.

At the close of this report no material change had taken place in the condition of affairs, except the unusually rapid caving of the river bank in the Marengo Bend, which has opened the river fully into Lake Concordia.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

JUNCTION OF THE MISSISSIPPI, RED, AND ATCHAFALAYA RIVERS, NEAR TURNBULL ISLAND, LOUISIANA.

A detailed description of the difficulties in this vicinity which the improvement are designed to rectify will be found in the last annual report. In general term these difficulties consist in the filling up of Old River, which is the only navigabl entrance from the Mississippi to the Red and Atchafalaya rivers and their tribu taries, so that low-water navigation is impeded and at times entirely obstructed.

This filling up is attributable in part to the deposit of sediment during high wate caused by irregular variations in the strength and direction of the current in Ol River, and in part to the caving in or sliding down of the soft banks adjacent to th channel during low water.

The complete system of works contemplated with a view to correcting these diff culties comprises the following objects:

To check the enlargement of the Atchafalaya and limit its outlet capacity by system of low relief dams or sills located near the head of this outlet river and ju below the point where the Bayou des Glaises comes in.

To separate the Red from the Atchafalaya during low water and up to mid stag by means of a low dam at the west end of Turnbull Island, which for all stage below the crest of the dam would deflect the Red around the upper side of Turnbul Island through upper Old River.

To complete the separation by cutting a canal across Carrs Point and obstructin the lower end of upper Old River, thus making the Red a tributary and the Atch falaya an outlet, separated from each other at medium and low stages; while th conditions at high stages are not to be materially modified.

The plan also contemplates maintaining low-water navigation through lower Ol River, if practicable, by dredging or otherwise, until the above system of works i completed.

The entire Red and Atchafalaya system, whose only outlet is now through th channels which these works are designed to improve and maintain, comprises a tota length of about 4,300 miles of navigable river in those stages during which ther are at present no difficulties in lower Old River. In low water, when such difficul ties are experienced, the navigable portion of the Red and Atchafalaya system i about 345 miles for a 3-foot draft and 132 miles for a 5-foot draft.

At the date of the last annual report the following work had been done:

Two sill dams near the head of the Atchafalaya, with the shore protection con necting levees and wing levees, had been completed.

The sill or foot mattress and shore protection work of the Red River dam ha been finished and the dam constructed temporarily at a height of 3 feet above th zero of Barbres gauge with a view to increasing the effect of scour in upper Ol River during the falling stage of the river after the high water of 1891. The dam was partly cut down again to afford a navigable channel over it for the low-wate season of 1891, leaving it at a height of about 5 feet above the zero of Barbre gauge for a width of 450 feet. No further work has been done on the dam.

The site of the Carrs Point Canal had been surveyed and the timber cut along th center line.

Some dredging had been done in upper Old River and the usual work of building temporary spur dikes and of dredging, with a view to maintaining low-water navi gation through lower Old River, had been done each low-water season.

A telegraph line connecting the Government depot at Barbres Landing with Wes Melville, La., on the Texas & Pacific Railway, the nearest telegraph station, ha been constructed.

Bids for building or leasing a dredging plant for this work were invited by adver tisement of June 1, 1892, under general specifications prescribing the condition which the plant was to fulfill, but leaving the detail of the plant to be proposed by the bidders. Bids were opened on August 1. Only one bid was received, that o the San Francisco Bridge Company, of San Francisco, Cal., who proposed to build pump dredge for $98,000. The bid was considered too high, and rejected.

Advertisements for a dredging plant designed specially for securing and maintain ing a low-water channel through lower Old River were issued on November 30, 1892 and opened on January 30, 1893. The bid of the Bucyrus Steam Shovel and Dredg Company, of Bucyrus, Ohio, who proposed to build a pump dredge for $69,500, wa accepted. Contract was entered into and construction of the dredge has begun It is to be delivered August 1, 1893. The hull of the dredge is to be of wood, about 95 feet long by 27 feet beam. The house will be double decked, the lower deck being occupied by dredging and propelling machinery, boilers, workshop, etc., and th upper deck affording accommodations for the crew. The propelling power will con sist of a stern wheel with a pair of driving engines, usual steamboat type. Th dredge will have pilot house and regular steering gear.

The dredging apparatus proper is to consist of a centrifugal pump with 15-inch suction and discharge, driven by compound condensing engines and supplied with

steam from two horizontal cylindrical boilers with corrugated internal furnace flues. The suction pipe is supported on an "A" frame pivoted at the bow of the hull, which enables the dredge to work on 30 feet of water. At the end of the A frame is a conical cast-steel cutter head for loosening the material. This cutter head is supported on a shaft and revolved by independent engines mounted on the forward deck through especially designed bevel gear. The discharge is to be through steel pipe supported on pontoons, or when working in low water through a length of pipe supported direct from the hull. The dredge is to have a practical capacity of 300 cubic yards of soft mud per hour. Work during the past year was confined to dredging in lower Old River.

The dredge *Pah-Ute*, belonging to the plant, a Hayward bucket dredge, belonging to Wood, Bodley & Co., of Baton Rouge, and a clam-shell bucket dredge, the *Herndon*, with tug and scows, belonging to Rittenhouse, Moore & Co., of Mobile, Ala., were employed.

Dredging began on September 5 and was continued until October 1, when the water became so low that it was necessary to suspend operations and remove the dredge.

The steamer *J. E. Trudeau* passed through Lower Old River on September 30, but had difficulty in getting through. From that date until early in November, when a light-draft boat passed through, navigation was entirely suspended, and more or less difficulty was experienced until November 19, when navigation was practically restored by a rise of water and a current through the channel which removed the sand deposits. The dredge *Pah-Ute* worked on the clay lumps between Ash Cabin and Dead Tree from December 4 to December 19.

The gauge at the head of Turnbull Island being no longer of any practical use was discontinued on September 10.

The levee on the Simmesport side between the sill dams in the Atchafalaya River was repaired and partly rebuilt, and repairs were made to the telephone line connecting the Government depot at Barbres Landing with Melville.

The usual observations to determine the low-water discharge of the Atchafalaya at Simmesport were made during October. The minimum discharge found was 12,506.25 cubic feet per second on October 16, 1892. Observations are now in progress to determine the high-water discharge.

Abstract of proposals received in response to advertisement dated June 1, 1892, opened at New Orleans, La., August 1, 1892, by First Lieut. John Millis, Corps of Engineers, for building or leasing a dredging plant for use at the works of improvement at the junction of the Mississippi, Red, and Atchafalaya rivers, near Turnbull Island, Louisiana.

No.	Name and address of bidder.	Building.	Leasing.	Total.
1	San Francisco Bridge Co., New York City	$89,000	No bid.	$89,000

Amount available from act of September 19, 1890	$85,000
Amount available from act of July 13, 1892	80,000
Total	165,000

REMARKS.—Recommendation was made that the above bid be rejected and that new advertisement be issued.

Abstract of proposals received in response to advertisement dated November 29, 1892, opened at New Orleans, La., January 2, 1893, by Capt. John Millis, Corps of Engineers, for building or leasing a dredging plant for use at the works of improvement at the junction of the Mississippi, Red, and Atchafalaya rivers, near Turnbull Island, La.

No.	Name and address of bidder.	Building.	Leasing.	Total.
1	Bucyrus Steam Shovel and Dredge Co., Bucyrus, Ohio	$69,500	No bid.	$69,500
2	San Francisco Bridge Co., San Francisco, Cal	87,000	No bid.	87,000
3	H. S. Brown, Quincy, Ill.*			

* Informal letter—no bid.

January 25, 1893, balance available	$150,873.85
Amount covered by this abstract	69,500.00
Balance	81,373.85

REMARKS.—Bid No. 1 is the lowest received, and the bidders, being responsible, is recommended for acceptance.

Money statement.

June 1, 1892, balance unexpended	$89,871.7
Amount appropriated by act approved July 13, 1892	80,000.0
	169,871.7
May 31, 1893, amount expended during fiscal year to date	29,898.7
May 31, 1893, balance unexpended	139,973.0
May 31, 1893, amount covered by uncompleted contracts	69,500.0
May 31, 1893, balance available	70,473.0
Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	350,000.0

NEW ORLEANS HARBOR.

The harbor of New Orleans consists of a total length of about 13 miles of the Mi sissippi River and comprises four bends and four comparatively straight reaches fro 2 to 3 miles in length. At two of the bends the river changes its direction somethin over 90 degrees, and the mean radius of curvature is about one and one-half time the river's width. The other two bends are less abrupt. The average width betwee bank lines at mid-stage is about 2,200 feet. At high water the average width bein determined by the levees which are not in all cases immediately on the banks i somewhat greater. The maximum depth at low water varies on different section from 70 to 160 feet, and the maximum difference between low and extreme high wate is about 19 feet. As the city is about 104 miles inland by the river from the Gulf o Mexico, the effects of the tides are very slight and quite irregular, varying with th stage of the river and the direction and force of the wind. The mean current varie from 5.6 feet per second in high stages to a scarcely perceptible current at extrem low water. The river usually reaches its maximum stage between March 1 and Jun 30 and its minimum stage between September 1 and November 30, and the variation in height are never abrupt.

The entrance to the harbor from seaward through South Pass affords a practica depth of over 25 feet, the depth of the other Passes or mouths of the river not bein sufficient for deep-draft sea-going vessels. From the head of the Passes to an throughout the harbor, the channel depth and width are ample, and in most portion of the river navigable depths exist close inshore. For a considerable portion of th river front on both shores, continuous wharves exist, and there are detached wharve and landings at more or less frequent intervals over a greater part of the entire wate front of the harbor.

The entire country in the vicinity of New Orleans is of recent alluvial formation, un disturbed by any subsequent geological changes, and it is consequently low and flat, be ing highest at the river banks, and having a gentle and regular slope away from th river. Borings made in this locality show alternate layers of sand and clay in vary ing thickness, to a great depth. During flood stages the river reaches a height of or 7 feet above the highest natural level in the city, and the levees, which are essen tial for the prevention of overflow, are as a rule necessarily built close to the bank line in order to meet the requirements of the various interests along the river front

The use of regular docks or slips and piers in the harbor is generally impracticable owing to the variations in the height of the water, the unstable nature of the banks the swift current at high stages, and the tendency to deposit large quantities of sil when the current is interfered with. Vessels are usually made fast alongside of th continuous wharves, and since there are no good anchorage grounds, particularly i high water, owing to the current, the great depth and nature of the bottom, the con ditions generally in the harbor are such as to require an unusual development o water front to accommodate a given amount of shipping.

Although the condition of the river and its banks in this vicinity is one of com parative stability when contrasted with the extraordinary changes which often occu in certain portions of the Mississippi above the mouth of Red River, the damag which results from even slight changes of the river in a port like that of New Orlean becomes serious.

In general the action of the river is to erode and cut away and cause caving an sliding down of the banks on the concave shore and for some distance below, result ing in the destruction of wharves, levees, streets, and sometimes of sheds and build

ings. When this action occurs on one bank a deposit of sediment and consequent shoaling and damage to the water front on the opposite shore usually takes place also. In certain localities caving of the bank has taken place in the straight reaches, and even on a convex shore. In such cases the action is attributable partly to the weight of large masses of sediment deposited under wharves during high water, which, when deprived by the fall of the river of the support which the water afforded during flood stages, causes large portions of the bank to crack off and slide down. Since caving on a straight or concave shore is not general and is irregular, the above theory as to the cause is not entirely satisfactory, and it must be largely influenced by some local cause.

Caving usually takes place only during falling and low stages of the river, but the erosion which is believed to be its main cause is undoubtedly most active during flood stages, and it seems to be well established that with the completion of the levee system there is a tendency of the river to enlarge its section and acquire the increased discharge capacity demanded of it.

In localities exposed to rapid erosion, where the bank is not protected, the danger of a breach in the levee during high water and an overflow into the city now necessitates building the levees at considerable distance from the bank line at such places.

The general object of the works of improvement in New Orleans Harbor is to check and if possible to prevent the detrimental action of the river as above described, and to maintain the river banks in a condition of permanency.

Under the approved project the work now in progress to accomplish these objects consists in the construction of submerged inclined spur dikes along the caving banks, which extend out normally to the bank line, and which have heretofore been placed at intervals of from 500 to 1,600 feet.

In addition to these dikes continuous bank revetment has been constructed in the intervals where the destructive forces have proved very active. This revetment has an average width of about 400 feet and extends from low-water line out to deep water, covering the entire bank slope. In building this revetment mattresses made of willow brush and poles and fastened with sawed timber and wire are first constructed in sections of convenient size and about 2 feet thick. These sections are then fastened together, forming a large mattress, which has a width of 130 to 150 feet and a length equal to the width of the revetment. This mattress is floated to position between lines of barges secured by mooring lines, and is sunk by loading it with rock evenly distributed over its surface. After it is sunk additional rock is deposited upon it. The spur dikes are built of successive layers of mattresses of diminishing width, constructed in a manner similar to that above described, except that they are made two to three times as thick, and the willows are so laid as to leave square "pockets" to receive and retain the rock. These mattresses or "cribs" are so designed that the top of the completed dike has a width of about 16 feet and a slope in the direction of the length of the dike of about 3 base to 1 perpendicular. Various side slopes have been given to the dikes, from 1 base to 1 perpendicular to 2 base to 1 perpendicular, the latter slope being now preferred. When the intervals have not been continuously revetted the dike rests on a foot mattress about 150 feet wide. In places in the harbor where the water front is required for docks the crest of the dike at the shore end is kept below the draft of vessels; at other localities the crest has been carried up to low-water line and continued up to the main levee by a spur levee built of earth and paved with rock.

The design is to begin sinking the mattresses during the end of the low-water season, but this has not always been practicable, and some of the work has been placed in comparatively high stages.

The effect which the continuous revetment is intended to produce is to cover the entire bank slope directly after the caving for the season has ceased and when the bank has presumably a form best adapted to stability and to protect it from further erosion. The dikes are designed to arrest caving by checking the velocity of the current and inducing a deposit and to support the bank. Spur dikes without immediate revetment have been successful in some of the straight reaches and on concave banks of large radius, but in the abrupt bends the dikes alone are only locally effective.

At the date of the last Annual Report the following work had been completed in general accordance with the project as above outlined. A continuous mattress 400 feet in length had been placed just above the caving bank in the Carrollton Bend. Five spur dikes had been built in the Carrollton Bend, two in the Greenville Bend, six in the Gouldsboro Bend, and eight in the third district reach.

All the above work remains in place and has proved successful, with the following exceptions: In the third district reach the caving was arrested and a general accretion took place along that portion of the bank covered by the four lower dikes built in 1889, except that a small cave has occurred between Dikes 3 and 4. Along that portion covered by the four upper dikes no further caving took place at the heads of the dikes, but caving continued in the intervals between Dikes 1 and 2, 2 and 3, and

below 5. There has been no noticeable accretion. In this locality the interv between dikes are evidently too great, and intermediate dikes should be built or t intervals protected with continuous revetments.

In the Gouldsboro Bend a small cave has occurred between Dikes 3 and 4, b otherwise the bank line has remained unchanged.

In the Carrollton Bend the five dikes all remained undisturbed and the bank li at their head was maintained, but caving between the dikes continued, and it beca evident that the radius of curvature of this bend is such that spur dikes alone not effective unless built with such short intervals as to render the work excessiv expensive.

Destructive caving has also taken place along the water front between Carroll and Exposition Wharf, at Eighth street, at the Soraparu Market, in the bend at below the French Market, and at Algiers Point. No protection work has been done these localities by the United States, but the city of New Orleans has constructed work and wooden bulkheads with a view to arresting the caving near the Fre Market, at Algiers Point, and in the intervals between the third district spur dik This work has been partially successful.

By the act of July 13, 1892, $80,000 was appropriated for continuing the work improvement in New Orleans, and a project was submitted on June 16, 1892, for expenditure of this sum in constructing continuous bank revetment in the interv between the completed dikes in the Carrollton Bend at Southport and the purch of additional barges for carrying on the work. This project having been appro advertisements were issued for six decked barges, but as the bids exceeded the e mate contract was entered into for four only. The barges have been completed delivered.

Contract was made with R. M. White, of New Orleans, for supplying the willo for the work, but as the delivery was too slow to meet the requirements a quar boat with force of men was sent to Profit Island and cutting of willows by hi labor began on September 22, 1892. Mr. White supplied 1,135.09 cords of willo and 54.06 cords of poles. The force at Profit Island furnished 3,690 cords of willo and 72 cords of poles. Rock was obtained partly by contract with J. W. Worthi ton & Co., of Birmingham, Ala., who shipped it by rail from their quarries n Birmingham and delivered it on board barges in the harbor for $2.50 per ton. Th supplied 3,749.25 tons of limestone rock of excellent quality. Nine hundred a ninety-seven and ninety-seven one hundredths tons were obtained by open-mark purchase of ships' ballast, delivered on board barges in the harbor at $1 per to Lumber was supplied by the Brakenridge Lumber Company, Limited, and H. West Lumber Company, and wire nails by Woodward, Wight & Co., Limited, under co tracts.

Owing to the late date at which the appropriation became available and the del in the delivery of willows, sinking of the mattresses did not begin until January 1893. The river had then reached a comparatively high stage. The swift curre and eddies in the bend and the large amount of drift running made a considerab portion of the operations of sinking difficult, but all the work was successfully plac without loss. One small section of mattress broke away, but it was recovered a replaced with no material damage to plant. The work was finally finished March 9, 1893, and its successful completion, under the difficulties which we encountered, reflect great credit on the assistant engineer in charge, Mr. Willia Garvin.

Six hundred and fifty-two thousand and twenty square feet of revetment we constructed at a field cost of $0.08919 per square foot. The cost of similar work la season was $0.09604 per square foot.

During July, August, and September a survey was made by Assistant Engine Garvin and Mott of the river front from Southport to the Exposition Wharf.

This survey was made on account of recent serious caving which had necessitat building new levees and the sacrifice of much valuable property, and it is antic pated that the protection work may be eventually extended down from Southpor

Money statement.

Balance unexpended June 1, 1892	$4,768.
Amount appropriated by act approved July 13, 1892	80,000.
	84,768.
May 31, 1893, amount expended during fiscal year	84,768.
Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	300,000.

Abstract of proposals received in response to advertisement dated October 1, 1892, opened at New Orleans, La., October 12, 1892, by Capt. John Millis, Corps of Engineers, for furnishing rock for New Orleans Harbor work.

No.	Name and address of bidder.	3,500 tons of 2,000 pounds.	Total.
		Per ton.	
1	Woodward, Wight & Co., Limited, New Orleans, La	$3.15	$11,025
2	The Birmingham Mining and Manufacturing Co., Birmingham, Ala	3.24	11,340
3	Gunning Gravel and Paving Co., Vicksburg, Miss	3.50	12,250

Amount available	$51,205
Amount covered by this abstract	11,025
Balance	40,180

REMARKS.—Recommended that all of the above bids be rejected and that new advertisement be issued.

Abstract of proposals received in response to advertisement by poster, dated November 2, 1892, opened at New Orleans, La., November 15, 1892, by Capt. John Millis, Corps of Engineers, for furnishing 3,500 tons of rock.

No.	Name and address of bidder.	3,500 tons.	Total.
		Per ton.	
1	Frederick M. Cabot, Gate City, Ala	$2.63	$9,205.00
2	W. L. Killebrew, Greenville, Miss. (Item No. 1)	1.84 2/3	6,471.50
2	W. L. Killebrew, Greenville, Miss. (Item No. 2)	2.70	9,450.00
3	Woodward, Wight & Co., Limited, New Orleans, La. (Item No. 1)	3.10	10,850.00
3	Woodward, Wight & Co., Limited, New Orleans, La. (Item No. 2)	2.75	9,625.00
4	Gunning Gravel and Paving Co., Vicksburg, Miss	2.99	10,465.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 1)	2.00	7,000.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 2)	2.15	7,525.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 3)	2.50	8,750.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 4)	2.25	7,875.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 5)	2.50	8,750.50
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 6)	2.75	9,625.00

Amount available	$51,205
Covered by this abstract	8,750
Balance	42,455

REMARKS.—Bid No. 5, items Nos. 3 and 5, as may be selected, is recommended for acceptance; it is the lowest and most advantageous bid received and considered reasonable.

Abstract of proposals received in response to advertisement dated October 1, 1892, opened at New Orleans, La., October 12, 1892, by Capt. John Millis, Corps of Engineers, for furnishing willow brush and poles for New Orleans Harbor works.

No.	Name and address of bidder.	On United States barges at willow grounds.		On contractors' barges at Exposition Wharf.		Total.
		4,500 cords willow brush.	400 cords willow poles.	4,500 cords willow brush.	400 cords willow poles.	
		Per cord.	*Per cord.*	*Per cord.*	*Per cord.*	
1	Robert M. White, New Orleans, La	$1.38	$3.00	No bid..	No bid..	$7,410
2	G. W. Reagan, Red River Landing, La	1.65	1.90	No bid..	No bid..	8,185
3	G. M. Long, Delta, La	1.70	2.17	No bid..	No bid..	8,518
4	Woodward, Wight & Co., limited, New Orleans, La	2.00	3.00	No bid..	No bid..	10,200
5	Tobias Nagel, M. D., New Orleans, La	2.15	3.25	No bid..	No bid..	10,975

Amount available	$58,615
Amount covered by this abstract	7,410
Balance	51,205

REMARKS.—Bid of Robert M. White is the lowest and is recommended for acceptance.

Abstract of proposals for levee work in Upper Tensas Levee District, etc.—Continued.

No.	Name of bidder.	Lakeport.		Below Lakeport, station 40 to 105	Adams Front.		Kigers Loop.		
		Station 1216 to 1292.	Station 1292 to 1368+66		Station 105 to 210.	Station 210 to 306.	Section 1, 50 stations.	Section 2, 30 stations.	Section 3, 23 stations.
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1	C. A. Winter	14	18	25	18	15	14⅛	14⅛	14⅛
2	Jeffries & Dameron	14	17	25	22	16	14½	15	17
4	John G. Sessions	14⅛	16⅞	24½	21½	17	15½	16⅛	16½
7	McTighe & Co	18	21	25	19	17	17	18	18⅛
8	P. F. Lamb						15⅞		
9	O. B. Crittenden	14 7/10	16	21	16⅛	16			
10	Michael McTighe						18	19	20
11	Charles T. Worthington						14½	14½	14½
12	Robert Johnson						15	15½	16
13	T. J. Bogue	20 88/100	19	19 44/100	18	17 99/100			
14	W. L. Killebrew	17	19	24	20	19	20	18	19
16	James M. Sullivan	12½			20½	18½	14½	15½	16
22	John and Thomas O'Hearn	16	21⅛	29⅛	34	34	15½	15½	16
24	W. L. Withers & Co	13	15	22	18	14⅛	16	15	17½
25	Stripling & Wright	16	18						
29	Harinut & O'Brien	15	21			18	15	16	18
32	James S. Peak	12	17⅛				12	15½	18⅛
33	Hebron, Hebron & Buck	18⅛	18⅛				16⅛	16	
35	McLaughlin Bros	17	19½		30	30	15	15	15
36	Tim Sullivan				18⅜	16⅜	13 88/100	13 88/100	13 88/100
37	M. V. Henry	27	27	33	33	33	17	17	17
38	Hebron, Hebron & Buck			20				16⅛	
40	J. A. Deaton & Co	15½	16⅛	24 44/100	18⅜	16⅛	16⅛	16⅛	16⅜
42	Arnold, DeGaris & Co	15⅜	16⅞	23⅜	15⅜	16⅞	15	15½	16
43	Kilpatrick & Storer				14 12/100	14 88/100			
44	Manning & Gibson						15	17	16⅛
45	Ernest Hyner	13 44/100	15 84/100	17 84/100	16 84/100	15 84/100			
46	J. B. Lewis	14½	*15	23	14⅜	14⅛	15½	16	17
48	Donovan & Daily	14 7/10					16 7/10	16 8/10	
51	John C. Hodge		19⅞	22½	23⅜	22⅞			
53	Whitehill Company					16			
54	Ben Talley						15½	15½	15½

* Contract awarded.

Abstract of proposals for levee work in Middle Tensas district, received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 16, 1895.

No.	Name of bidder.	Villa Vista Levee.			Salem Levee.	
		Upper section.	Middle section.	Lower section.	Upper section.	Lower section.
		Cents.	Cents.	Cents.	Cents.	Cents.
1	C. A. Winter	15	24	22		
2	Jeffries & Dameron	15	21	20	17	15
4	John G. Sessions	18 1/8	24⅛	21⅜	21⅜	17⅞
6	Starling & Smith Co				25	19
7	McTighe & Co	21	28	25	23	20
12	Robert Johnson	17⅛	18⅛	18	16⅛	18⅛
14	W. L. Killebrew	19	22	25	23	21
15	Robert Nicholson				29	14 88/100
16	Jas. M. Sullivan	15⅛				15½
17	Albert S. Colthorp			21 88/100		
20	F. L. Maxwell	17⅜				18⅜
21	Edmund T. White	28	26	25	22	22
23	Wm. J. McGinty	18				17
24	W. L. Withers & Co	15⅛	20⅛	*17	20	16⅛
35	McLaughlin Bros	16	19	19	19	16⅜
36	Tim Sullivan	15	24	22		
37	M. V. Henry	14 23/100	18 97/100	18⅜	19⅜	15
39	John Scott & Son	14 76/100	18 76/100	17 44/100	17 44/100	14 76/100
40	J. A. Deaton & Co	16⅛	19	17	19	19
42	Arnold, DeGaris & Co	19⅛	23	21⅛	22⅛	18
44	Manning & Gibson	15			16	14 88/100
46	J. B. Lewis	16	23	21	24	16
48	Donovan & Daily	19 8/10			19 8/10	18 8/10
49	J. Stein & Co	15 76/100	22 8/10			
51	John C. Hodge	15⅛	19⅛	19½	19⅜	15⅜

* Contract awarded.

The quantity and value of material was as follows:

3,749 tons rock, at $2.50 per ton	$9,373.12
997.97 tons rock, at $1 per ton	997.97
10,000 feet, B. M., 3 by 6 lumber, at $12 per M	120.00
3,320 feet, B. M., 3 by 6 lumber, at $11 per M	36.54
66,442 feet, B. M., 3 by 6 lumber, at $10.45 per M	694.32
9,464 feet, B. M., lumber, at $10 per M	94.64
188,745 feet, B. M., 2 by 4 lumber, at $9.95 per M	1,878.01
50 pounds 9-inch steel wire nails, at 3 cents per pound	1.50
1,450 pounds steel wire nails, 6-inch, at 2¼ cents	30.45
450 pounds 3½-inch steel wire nails, at 2.45 cents	11.02
6,900 pounds 9-inch steel wire nails, at 2½ cents	172.50
13,400 pounds 6-inch steel wire nails, at 1.95 cents	261.30
1,600 pounds 3½-inch steel wire nails, at 2.4 cents	38.40
6,961 pounds No. 10 wire, at 2.45 cents per pound	170,54
4,825 cords willow brush, at $2.36 per cord	11,387.00
739 cords willow brush, at $1.9425 per cord	1,435.50
1,135 09 cords willow brush, at $1.38 per cord	1,570.56
54.06 cords willow poles, at $3 per cord	162.18
Labor, superintendence, etc	18,585.80
Tugs, with crew, fuel, material, etc	5,649.95
Provisions, with ice and fuel, for cooking	5,487.75
Total	58,159.05
Cubic feet of mattress work	1,428,618
Square feet of mattress work	652,020
Pounds of rock per square foot to sink	14.56
Cost per square foot in place	$0.08919

The first mattress was completed November 6, and the first was sunk January 6, two months after completion. The delay was caused by all the barges being engaged in transporting willows and rock.

The last large mattress was completed on December 31, 1892, and the last large mattress was sunk February 2, 1893. They were sunk in the following order: Between Spur Dikes 4 and 4½ from January 6 to 13; mattress below Spur Dike 4½ sunk on January 17; mattress between Spurs 3½ and 4 sunk from January 21 to 26; mattress between Spur Dikes 3 and 3½ sunk from January 29 to February 2; mattress on head of Spur Dike 4 sunk February 6—the construction of this mattress was completed on January 20; mattress 105 by 150 feet was sunk on head of Spur Dike 4½ February 16, and mattress 105 by 60 feet on March 7.

The small mattresses in cave between Spurs 4 and 4½ were sunk from February 25 to March 9.

The construction of the mattresses were the same as those previously sunk in the Southport Bend, with the exception of the lower frame, which was built of 3 by 6 inch lumber to give greater strength to resist the strain of the downstream lowering lines. No iron rods were used for strengthening the mattress, as they were formerly; the top line of poles were all securely nailed and wired, and an additional line placed near each toggle-pin, which gives all required strength and are cheaper than rods.

During the rise in December considerable difficulty was experienced in keeping the completed mattresses moored to the bank, owing to the large quantity of driftwood accumulating against them, and considerable washing was done to keep them floating until barges were available for sinking. During the sinking of the large mattresses the river was falling, no drift was running, and the weather was favorable for the work. The smaller mattresses were sunk during a rising river, with large quantities of driftwood running, and considerable difficulty was experienced in handling the mattresses and placing the barges in position, owing to the cross-currents and large accumulation of driftwood in the eddy between Spur Dikes 4 and 4½.

The cost per square foot for mattress work was $0.00685 less than for the previous season; 3,749.25 tons of rock used was brought by rail from Alabama and loaded on the United States barges at New Orleans, the contract price being $2.50 per ton, delivered on barges.

Nine hundred and ninety-seven and ninety-seven one-hundredths tons of rock was purchased from different sailing vessels in the harbor, at $1 per ton, loaded on the United States barges. A total of 1,143.91 tons was purchased in the harbor, of which 93.94 tons was unloaded on the bank at Southport.

One thousand one hundred and thirty-five and nine one-hundredths cords of brush and 54.06 *cords of poles* were cut by contract below New Orleans, and 4,825 cords

of brush was cut by the United States employés at the willow... Island; 739 cords was on hand at Southport.

On completion of work at Southport the plant was moved to l... at the Exposition wharf, all lines, tools, and other property clear... the warehouses.

Repairs.—The tug *General Comstock* was entirely rebuilt and rem... was, labor on repairs, $3,476.83; material, $1,383.90; pay of crew, $... repairs to machinery, $298.94. Total, $5,569.98. Previously repo... repairs, $1,657.54; material, $603.32; making a total of $7,830.84 for ... includes new house, new capstan, and propeller.

The tug was employed during the month of September on levees, und... Assistant Engineer Douglas.

The cost of running the tug while under my charge, from October 1, 18... 1, 1893, was: Material, $166.99; pay of crew, $1,459.95; fuel, $777.10; r... machinery, $627.15; of this amount $2,404.04, or all excepting the repairs to ma... was charged to mattress construction.

Tug *Tilda* was employed on levees until June, when she was tied up at E... tion Wharf until September. During this time she was docked and the hull pa... and minor repairs to house and machinery; the cost was, labor for repairs, $3... material, $172.17; pay of crew, $300.50; fuel, $352; a total of $1,114.99 for re... The cost of running the tug during mattress construction was: Labor on re... $71.75; material, $461.64; pay of crew, $1,617.42; fuel, $1,166.85; repairs to machin... $529.54; of this amount $3,245.91, or all except labor on repairs and repair... machinery, was charged to mattress construction.

The repairs on steamer *Gen. Newton* were done under my supervision, and consi... of extensive repair to deck forward and aft, new quarters for deck crew, mak... changes in cabin, putting down new steam capstan, repairs to machinery, new bre... ing and smokestacks and new woodwork of wheel, and minor repairs to cabin, ca... fenders, railing, nosing, and machinery at different times from date of last repo... March 31, 1893. The cost was, for labor, $1,632.24; material, $1,242.99; a tota... $2,875.23 for repairs.

Launch No. 5 was engaged with survey party during month of September, and ... used on works for supplying steam to engine on deck, and for pumping bar... From December 3 to 12 she was engaged on levees with Assistant Engineer W... Hardee, and from January 6 to 24, 1893, on levees with Assistant Engineer W... Price. The launch was docked and hull cleaned and painted in July and Aug... 1892. The cost while under my supervision was, pay of crew, $244.59; fuel, $7... repairs, $240.63; a total cost of $560.32.

Launch *Ruby*. The following repairs were made under my supervision in the m... of June: New tubes were put in boiler, casing around furnace repaired and furn... rebuilt, pump repaired, new flooring put down in kitchen and fire room. Cost w... Material, $68.30; labor, $80.27; repairs to machinery, tubes, etc., $165.25. In the m... of October, 1892, the launch was put in dock, the hull tarred, calked, and pain... entire new rake planking of oak lumber put in, new woodwork in wheel, the w... work on roof repaired, and new canvas put on roof, new breeching for smokest... some new brasses, and rudder repaired. Cost was: Material, $55.96; labor, $338... a total of $688.28 for repairs.

Launch *Alaska* had extensive repairs to boiler and machinery; has been doc... twice and hull scraped and painted and new stern bearing put in, new fender str... put on; the house has been repaired and some minor repairs have been made to ho... The launch was engaged with Assistant Engineer W. J. Hardee on levees fifty... days.

The principal service rendered in the harbor was towing small barges with m... rial from Canal street to works. The cost was: Pay of crew, $275.27; fuel, $72... labor on repairs, $281.77; repairs to machinery, $431.50; a total cost of $1,061.04.

Barge No. 5: Repairs consisted of entire new sides, rakes, head blocks, deck be... and deck. After completion of the new work the barge was turned over and ... bottom calked. The cost was: Material, $450.99; labor, $2,366.43; a total of $2,81...

Barge No. 4: Repairs consisted of entire new sides, rakes, head blocks, deck be... and deck. After completion of the new work the barge was turned over and ... bottom calked and repaired. The cost was: Material, $648.93; labor, $1,540.4... total of $2,189.39.

Barges Nos. 9, 11, 12, and 14 were turned over, the bottoms calked and repaired. ... cost was: Material, $302.19; labor, $1,342,49; making a total of $1,644.68.

Quarter boat *Beta:* Repairs consisted of new hull and minor repairs to house. ... cost was: Material, $204.54; labor, $599.12; total, $803.66.

Quarter boat *Alpha:* Repairs consisted of new hull and minor repairs to house. ... cost was: Material, $304.95; labor, $648.57; total, $953.52.

Quarter boat *New Orleans*: Minor repairs to house. The cost was: Material, $8... and labor, $93.13; total, $175.25.

The quantity and

,749 tons rock, at
97.97 tons rock, at
0,000 feet, B. M.
,320 feet, B. M.,
6,442 feet, B. M.,
,464 feet, B. M.,
88,745 feet, B. M.
0 pounds 9-inch
,450 pounds steel
50 pounds 8-inch
,900 pounds

Gamma, minor repairs to windows and head blocks. The cost was, labor, $106.75; new cooking range, $104.20; total, $216.61.

Ute.—Repairs consisted of new deck and deck beams, new topsides, ber black head, new braces under deck, and bucket crane and braces coal bunkers, new canvas roof, and other minor repairs to house. The me during July and August, 1892, and the cost was: Material, $660.72; 76; total, $2,233.48. The dredge worked in Old River during the low- in of 1892 and was returned to New Orleans in February, 1893. The buck- ne have been taken off the spud, post frames repaired and braced, the eak repaired, deck house strengthened, cylinder timbers put down, and ne fastened in place. The cost was: Material, $29.73; labor, $482.36; total,

3,400 pound
,600 pound
,961 pou
,825 co
39 c
1,19

B.—Head blocks and deck were repaired. The cost was, for labor, $108.15.

: Minor repairs were made to the different skiffs. The cost was: Material, labor, 40.35; total, 46.05.

ock barge was turned over and bottom repaired and calked. Two pieces of harf timber 12 inches square and 75 feet long was bolted on bottom to give addi- tional stiffness and strength to the bottom. The cost was: Material, $38.75; labor, $186 00; total, $224.75.

Barge *C.*—House was built on this barge to serve as quarters for engineers and inspectors on levees below New Orleans. The cost was: Material, $39.41; labor, $203.94.

The lumber used in building house was material left from levees, and no charge has been made for lumber.

Barge *A.*—This barge has been fitted up with pile-driver engine and all complete; the cost was: Material, $4.80; labor, $113.01; total, $117.81.

Care of plant: There has been expended for material, $1,160.17, and for labor, $2,970, a total of $3,130.17.

New plant.—Four new barges of the standard size have been constructed; two contracted for by the Pelican Sawmill and Manufacturing Company, built at their mill on the New Basin Canal which cost $3,287 each, and two contracted for by Christian Telson, built at the head of Louisiana avenue cost $3,650 each. The first barge was completed and delivered March 4, and the last completed and delivered on April 27, 1893. The total cost of the four barges was $13,874. The cost for inspection was $445.

Surveys.—Survey has been made of the Carrollton Bend extending from Spur Dike 3, Carrollton Bend, down to and including the exposition wharf. This survey includes the old and new levees, streets, and principal buildings; each section of sounding was carried out until the deepest portion of the river bottom was passed. The field work was done by Mr. G. Ed. Mott, during the month of July and August, 1892, with falling river.

Survey was also made during the months of January, February, and March, 1893, over the spur dikes in the Carrollton Bend and the mattresses sunk during the past season three lines of soundings were taken over each dike and mattress. The field work on these surveys cost $639.26.

Value of tools lost during season's work, $24.50; value of manilla and wire rope lost during the season's work, $192.44.

Very respectfully, your obedient servant,

WM. GARVIN,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

LEVEES.

The levee work of the fourth district having largely increased during the past year a redivision of the district into sections or sub-levee districts was suggested and approved by the commission at its meeting in August last. This subdivision is designed to afford greater convenience in making allotments, in executing the work of construction and repair, in maintaining the levees during high water, and to secure greater economy and efficiency in general administration of levee affairs, which have now become one of the most important parts of the work in charge of this district. The first season's experience under the new arrangement has been highly satisfactory.

The subdivisions now adopted are as follows:

The Lower Tensas Levee district, right bank, which extends from the upper limits of the fourth district, opposite Warrenton, to the mouth of Red River, and comprises 157¼ miles of the Mississippi River. In this district the levee system is continuous *from the upper* end down to a point 5 miles below Fairview Landing, a *length of 130.5 miles of* the river, leaving about 28 miles of river on this bank

unleveed. For this distance the lands along the west bank are, therefore, subject to overflow from the Mississippi, and they are also exposed to back water from the lower Red, which is unleveed.

The Atchafalaya Levee district, right bank, which extends from the mouth of Red River to the head of Bayou Lafourche, a distance of 122 miles by river. The levee system in this district is continuous.

The Barataria Levee district, right bank, which extends from New Orleans to the head of the passes, 102.5 miles. The levee system is practically continuous down to the Jump, an opening through the bank of the main river about 10 miles above the head of the Passes. In the lower parts of the district, however, the strip of cultivated land is narrow and the variations in the height of the river become comparatively slight and the levees are small affairs. The total length of river covered by levees is 91.5 miles.

The Lafourche Levee district, right bank, which extends from the head of Bayou Lafourche to New Orleans. The distance by river is 71 miles, and the levee system is continuous.

The Pontchartrain Levee district, left bank, which extends from New Orleans to Baton Rouge. It comprises 123.5 miles of the river, and the levees are continuous.

The Lake Borgne Levee district, left bank, which extends from New Orleans to the head of the Passes, 102.5 miles. The levee system only extends at present to Fort Jackson, covering 82 miles of the river, and the same remarks concerning the low portion of the Barataria Levee district apply to corresponding parts of the Lake Borgne Levee district.

Between Warrenton and Baton Rouge the river follows the general direction of the bluff line on the left bank, being at no point at any great distance from the high land. Numerous detached private levees exist along this portion of the river, which are more or less efficient, and which are designed solely for the local purpose of protecting the cultivated bottom lands between the river and the bluffs from overflow. Certain surveys having been directed by the commission between Warrenton and Natchez on the left bank, the name Big Black Levee district has been adopted for convenience to designate this locality. No work has been done in this district by the Federal Government.

Assistants have been assigned to the local charge of levee districts, as follows:

Assistant Engineer H. S. Douglas to the charge of the lower Tensas and Big Black Levee districts, in addition to his duties in charge of the work of improvement of the harbor of Natchez and Vidalia, and of certain gauges.

Assistant Engineer W. J. Hardee to the charge of the Atchafalaya, Lafourche, and Pontchartrain Levee districts.

Assistant Engineer W. G. Price to the charge of the Barataria and Lake Borgne Levee districts until February 16, 1893. Since that date Surveyor John Smyth has been in temporary charge of these districts.

Up to the date of the last annual report levee construction and extensive repairs had been done by the Federal Government in the fourth district at the following-named points:

Name of levee and levee district.	Bank.	Miles below Cairo.	Ye
Lower Tensas Levee district.			
Bedford	R.	606.5	1
Point Pleasant*	R.	624.0	1
Do*	R.	624.0	1
Hardtimes to Wilson	R.	631.0	1
Ships Bayou to Hardtimes	R.	633.0	1
Do	R.	633.0	1
Evergreen	R.	637.0	1
Hardscrabble	R.	639.0	1
Hardscrabble and Bondurant	R.	640.0	1
Kempe	R.	658.0	1
Do	R.	658.0	1
Do	R.	659.0	1
Do	R.	659.0	1
Gibsons	R.	683.5	1
Lake Concordia	R.	694.0	1
Do	R.	694.0	1
Ferriday	R.	694.0	1
Do	R.	694.0	1
Ferriday Break	R.	694.0	1
Arnauldia	R.	702.0	1
Hendersons	R.	713.0	1
Greens to Fairview	R.	720.0	1
Deer Park	R.	722.5	1
Do	R.	722.5	1

*Nearly all thrown out by new State levee.

Name of levee and levee district.	Bank.	Miles below Cairo.	Year.
Atchafalaya Levee district.			
Atchafalaya to Red River*	R.	765.0	1883
Hog Point to Raccourci*	R.	767.0	1883
Raccourci Crevasse*	R.	775.0	1883
Morganza*	R.	789.0	1887
Stewarts*	R.	791.0	1883
Nina	R.	806.5	1891
Highland Extension	R.	815.5	1893
Highland	R.	815.7	1891
Barroza	R.	824.0	1891
Mayflower—Union	R.	853.0	1892
Fortville	R.	855.0	1892
Evergreen	R.	857.0	1891
Dunboyne	R.	865.0	1892
Pontchartrain Levee district.			
Shannon	L.	837.0	1891
Martinez	L.	842.0	1891
Gay to Hollywood	L.	845.0	1891
Woodstock	L.	847 5	1891
Hermitage	L.	850.0	1891
Grenada to Mount Olive	L.	855.5	1891
Southwood Extension	L.	875.5	1892
Do	L.	875.5	1891
Ashland to Linwood	L.	878.0	1891
Dicharry	L.	882.0	1891
Irvine	L.	892.5	1891
Union	L.	893.5	1891
Lilly	L.	900.5	1891
College Point to St. Michael	L.	903.5	1890
Tessier—Bourgeois	L.	909.5	1892
Terre Haute to Hope	L.	919.5	1891
Cornland	L.	922.0	1891
Destrahan	L.	939.0	1891
Frellson to Almedia	L.	942.5	1891
Southport	L.	955.5	1892

* Afterwards extensively enlarged by State and partly abandoned, so identity of United States work no longer preserved.

The foregoing does not include work of minor repairs nor work done to assist in protecting and maintaining the levees during high water.

Protection work had been general throughout a greater portion of the district.

From the appropriation of July 13, 1892, a total of $655,000 was allotted for levee work in the fourth district. This was distributed among the several levee districts and reserves made for high-water protection, as shown in the accompanying money statements.

The localities at which the funds were to be applied were determined by the approved recommendation of the board of officers on building and repairing levees, whose recommendation was submitted on August 29, 1892, after a tour of inspection of the entire river from Memphis down to as far below New Orleans as contemplated work extended, and after consultation with numerous State and levee officials and with interested citizens.

The details of levee work completed up to the present date under the allotmentd from the appropriations of July 13, 1892, and balance on hand are given in condenses form in the following tables:

Fourth district levees, 1892–'93.

LOWER TENSAS LEVEE DISTRICT.

Name and levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section.		
						Crown.	River slope.	Land slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*		
Hardscrabble, lower	640.4 R.	J. S. McTighe & Co.	5,348	4,650	2½	8	3 to 1	2½ and 4 to 1
Bondurant	643.5 R.	Manning & Gibson	3,417	2,550	2½	8	3 to 1	2½ to 1
Grassmere to Wiccema	693 R.	McLaughlin Bros.	26,400	5,500	2½	8	3 to 1	2½ to 1
Wiccema to Fletcher.	698 R.	Manning & Gibson	26,313	4,500	2½	8	3 to 1	2½ to 1
Fletcher to Minorca	699 R.	Rutherford & Dalgam.	18,399	12,000	2½	8	3 to 1	2½ to 1
Minorca to Minors	702 R.	Albert Henry Gillespie.	17,775	14,000	2½	8	3 to 1	2½ to 1
Morville	710 R.	Manning & Gibson	5,200	4,300	2½	8	3 to 1	2½ to 1
Fish Pond	732 R.	William O. Flynn & Co.	6,365	4,000	2½	8	3 to 1	2½ to 1

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavation.		Tile drains.	
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	Linear yards.	Price per linear yard.
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*		*Cents.*
Hardscrabble, lower	1.4	17.8	11.4	80,791.88	25	3,581.86	25	.....	.....
Bondurant	3.5	13.8	6.5	23,736.12	15 9/10	None.	.....	.....	.....
Grassmere to Wiccema	2.2	8.1	6.0	108,205.45	17½	206.03	16	.....	.....
Wiccema to Fletcher	1.2	10.2	7.2	125,996.46	16 48/100	5,172.71	16 48/100	7,292½	35
Fletcher to Minorca	3.7	12.6	7.0	117,789.84	15 4/10	1,677.00	15 4/10	.....	.....
Minorca to Minors	1.8	9.0	6.5	85,244.40	14	584.72	13 42/100	.....	.....
Morville	2.3	9.7	5.9	28,040.86	14 84/100	551.66	14 84/100	.....	.....
Fish Pond	5.4	12.1	8.7	59,921.07	15½	789.69	15½	.....	.....

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work completed.
	Lin. ft.					
Hardscrabble, lower	4,860	Oct. 31, 1892	Mar. 1, 1893	May 1, 1893	Nov. 8, 1892	Apr. 29, 1893
Bondurant	None.	....do	Feb. 15, 1893	None.	Nov. 14, 1892	Dec. 30. 1892
Grassmere to Wiccema	194	Nov. 9, 1892	....do	June 30, 1893	Nov. 3, 1892	
Wiccema to Fletcher	2,880	Nov. 7, 1892	....do	Apr. 15, 1893	....do	Apr. 24 and 25, 1893.
Fletcher to Minorca	3,059	Nov. 14, 1892	Mar. 1, 1893	June 1, 1893	Nov. 14. 1892	
Minorca to Minors	1,244	....do	....do	June 30, 1893	Nov. 15, 1892	
Morville	1,400	Oct. 31, 1892	Feb. 15, 1893	None.	Nov. 3, 1892	Dec. 27, 1892
Fish Pond	None.	....do	Mar. 1, 1893	May 1, 1893	Feb. 15, 1893	May 3, 1893

Name of levee.	Embankment, distance from center of levee to river bank.			Nature of river bank.	Remarks.
	Min.	Max.	Mean.		
	Feet.	*Feet.*	*Feet.*		
Hardscrabble, lower	1,500	2,450	1,975	Caving	New.
Bondurant	1,300	1,800	1,550	Caving rapidly	New.
Grassmere to Wiccema	2,200	16,000	16,000	Permanent on lake bank..	Enlargement. Tiling not completed.
Wiccema to Fletcher	12,000	20,000	16,000	.....do	New and enlargement.
Fletcher to Minorca	6,000	12,000	9,000	.....do	New and enlargement. Tiling not completed.
Minorca to Minors	3,000	6,000	4,500	.....do	New and enlargement. Tiling not completed.
Morville	1,200	1,400	1,300	Caving	New.
Fish Pond	3,300	3,600	3,450	Caving rapidly	New. Line to be extended.

Fourth district levees, 1892-'93—Continued.

ATCHAFALAYA AND LAFOURCHE LEVEE DISTRICT.

Name of levee.	Miles below Cairo and Bank.	Contractor.	Length of line.	Length of axis of river covered	Grade of levee above high water of 1892.	Section.		
						Crown.	River slope.	Land slope.
Atchafalaya district.								
			Feet.	*Feet.*	*Feet.*	*Feet.*		
Barroza, upper	823 R.	Andrews Bros. Construction Co.	4,407	2,875	2½	8	3 to 1	2½, 4, & 6 to 1
Barroza, middle	823 R.	John Scott & Son	2,400	1,920	2½	8	3 to 1	2½, 4, & 6 to 1
Belair	828 R.	Timothy W. Scott	2,251	3,550	2½	8	3 to 1	2½ & 4 to 1
Eliza	842 R.	W. J. Bentley & Co.	2,609	2,780	2½	8	3 to 1	2½ & 4 to 1
Medora	852 R.	Sterling Fort	3,442	2,975	2½	8	3 to 1	2½ to 1 & 2½ & 4 to 1
Fortville, lower	855 R.	Ovide Lacour	2,055	1,680	2½	8	3 to 1	2½ & 4 to 1
Lafourche district.								
Buena Vista-Minnie	896 R.	James M. Sullivan	4,370	3,540	2½	8	3 to 1	2½ & 4 to 1
Jamestown	897 R.	James N. Ogden	1,400	1,260	2½	8	3 to 1 and 2½ to 1	2½ & 4 to 1
St. James Church	901 R.	W. O. Flynn	8,462	8,690	2½	8	3 to 1	2½ to 1
St. James estate	902.5 R.	James M. Sullivan	1,325	1,375	2½	8	3 to 1	2½ to 1
Home Place	905.5 R.	Homan, McFadden & Cassidy.	3,482	3,380	2½	8	3 to 1	2½ & 4 to 1
Lone Star	941.5 R.	P. J. Coffman	4,415	4,030	2½	8	3 to 1	2½ & 4 to 1
Davis	943 R.	John E. Louque	1,900	1,660	2½	8	3 to 1	2½ & 4 to 1

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavation.		Tile drains.	
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	Linear yards.	Price per linear yard.
Atchafalaya district.									
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*		*Cents.*
Barroza, upper	1.4	18.5	15.3	137,287.84	27½	2,886.10	27½	1,561	55
Barroza, middle	15.6	19.1	18.3	106,719.57	30½	1,177.68	16	832½	30
Belair	1	12	11.6	42,851.91	19½	238.01	10	.....	.....
Eliza	.6	12.4	11.8	47,737.36	18	353.72	18	.....	.....
Medora	.3	13.1	12.1	66,826.99	20	1,332.28	20	1,027½	50
Fortville, lower	.3	11.5	11.3	36,850.99	20½	1,244.69	20½	712	29
Lafourche district.									
Buena Vista-Minnie	.5	13.7	11.4	79,909.47	19½	2,363.19	19½	1,575½	50
Jamestown	.9	10.9	10.2	18,345.26	19 70/100	1,208	19 70/100	406½	40
St. James Church	2.5	10.5	9.3	98,748.55	17	5,121.59	17	2,889	40
St. James estate	3.2	10.3	9.4	15,133.01	18½	572.62	18½	.....	50
Home Place	.9	13.4	11.5	63,653.78	19½	1,443.74	18	1,118½	30
Lone Star	2.3	12	10.1	60,921.53	20	2,541.21	14	1,539½	30
Davis	2.8	14.6	13	42,666.26	21	926.25	21	711½	50

Fourth district levees, 1892–'93—Continued.

ATCHAFALAYA AND LAFOURCHE LEVEE DISTRICT—Continued.

Name of levee.	Muck Ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work plet
Atchafalaya district.	*Lin. ft.*					
Barroza, upper	1,500	Nov. 7, 1892	Mar. 1, 1893	Apr. 16, 1893	Nov. 4, 1892	Apr. 1
Barroza, middle		....do	....do	Apr. 15, 1893	Nov. 23, 1892	Apr.
Belair		....do	Feb. 1, 1893	Mar. 1, 1893	Nov. 21, 1892	Feb. 1
Eliza		Feb. 20, 1893	Apr. 1, 1893		Feb. 10, 1893	Apr.
Medora		Nov. 7, 1892	Feb. 1, 1893	Apr. 7, 1893	Nov. 1, 1892	Apr.
Fortville, lower		Nov. 4, 1892	....do	Feb. 10, 1893	Nov. 8, 1892	Feb.
Lafourche district.						
Buena Vista-Minnie	650	Oct. 31, 1892	Feb. 1, 1893	Apr. 20, 1893	Nov. 1, 1892	Apr. 2
Jamestown	300	Nov. 7, 1892	Dec. 15, 1892	Dec. 31, 1892	Nov. 10, 1892	Dec. 3
St. James Church	1,620	Oct. 31, 1892	Mar. 1, 1893	Apr. 15, 1893	Oct. 31, 1892	Apr.
St. James estate	150	....do	Dec. 15, 1892	Jan. 5, 1893	Nov. 2, 1892	Jan.
Home Place		Nov. 7, 1892	Feb. 1, 1893	Mar. 15, 1893	....do	
Lone Star		Nov. 5, 1892	Feb. 15, 1893		Nov. 29, 1892	Apr. 2
Davis		....do	Feb. 1, 1893	Apr. 1, 1893	Nov. 2, 1892	Mar. 3

Name of levee.	Embankment, distance from center of levee to river bank.			Nature of river bank.
	Min.	Max.	Mean.	
Atchafalaya district.	*Feet.*	*Feet.*	*Feet.*	
Barroza, upper	1,000	1,430	1,215	Caving bank at lower end.
Barroza, middle	1,150	1,490	1,320	Caving rapidly.
Belair	470	1,330	1,060	Washing bank.
Eliza	400	570	485	Washing and caving.
Medora	550	900	600	Caving, from appearance of mat
Fortville, lower	450	550	500	Caving slowly.
Lafourche district.				
Buena Vista-Minnie	350	580	480	Caving bank.
Jamestown	160	400	330	Caving bank near upper end.
St. James Church	140	350	270	Washing bank.
St. James estate	240	300	250	Do.
Home Place	590	800	700	Caving rapidly.
Lone Star	160	400	250	Permanent bank.
Davis	340	530	435	Do.

PONTCHARTRAIN LEVEE DISTRICT.

Name of levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section.	
						Crown.	River slope.
			Feet.	*Feet.*		*Feet.*	
Lopez	844.5 L.	C. S. Jones	1,757	1,085	2½	8	3 to 1
Burtville	847 L.	Homan, McFadden & Cassidy.	4,727	3,610	2½	8	3 to 1
Towles	851 L.	E. W. Hanlon & Co	1,339	1,210	2½	8	3 to 1
Billings	852.3 L.	....do	3,345	3,500	2½	8	3 to 1
Jolisant	858.8 L.	C. S. Jones	1,498	1,355	2½	8	3 to 1
Oakley to St. Gabriel.	862 L.	Homan, McFadden & Cassidy.	4,211	3,340	2½	8	3 to 1
Dicharry, lower	883 L.	James M. Sullivan	4,826	5,456	2½	8	3 to 1
Burnside	891 L.	Israel R. Bobbitt	3,520	2,850	2½	8	3 to 1
Union, upper	893 L.	P. J. Coffman	1,578	1,580	2½	8	3 to 1
Union, lower	893 L.	Jeffries & Dameron	784	790	2½	8	3 to 1
Tippecanoe	894 L.	Israel R. Bobbitt	3,080	3,140	2½	8	3 to 1
Peytavin	894.5 L.	Jeffries & Dameron	1,010	985	2½	8	3 to 1
White Hall	895 L.	McLaughlin Bros	590	1,040	2½	8	3 to 1
Tessier	909.5 L.	Jeffries & Dameron	4,154	3,910	2½	8	3 to 1
Hope	916.5 L.	P. J. Coffman	4,700	8,600	2½	8	3 to 1
Trudeau	949 L.	....do	3,570		2½	8	3 to 1

Fourth district levees, 1892-'93—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavation. Cubic yards.	Filled excavation. Price per cubic yard.	Tile drains. Linear yards.	Tile drains. Price per linear yard.
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*		*Cents.*
Lopez	1.4	10.3	10	22,184.30	18 3/10	114.77	18 3/10		
Burtville	1.5	14	13.2	109,535.44	21	1,630.47	16	1,657½	29
Towles	0.8	9.8	9.5	15,866.32	19 74/100	352.94	15		
Billings	0.8	10.5	9.3	39,490.21	19 1/10	374.19	15		
Jolisant	2.7	11.2	10.1	20,090.18	18 3/10	230.07	18 3/10		
Oakley to St. Gabriel	0.1	12.3	10.8	66,681.90	19	2,623.21	15	1,461½	27
Dicharry, lower	0.8	13.1	10.6	76,324.33	19	1,658.35	19	1,621½	50
Burnside	0.3	11.9	8.8	40,025.52	17 32/100	1,587.20	12	1,294½	30
Union, upper	0.5	9.3	8.9	15,770.65	22	1,460.08	20	571	30
Union, lower	1.1	9.6	8.5	7,582.29	22	961.08	20	274½	30
Tippecanoe	0.6	9	8.2	28,356.47	19	289.41	16		
Peytavin	0.9	7.7	7.2	7,191.66	20	629.86	20	350½	30
White Hall	0.7	8.1	7	4,389.15	21½	207.48	21½		
Tessier	1.5	12.5	12	76,963.56	21½	1,286.20	18	1,356½	30
Hope	2.5	12.1	9.6	57,394.11	18 44/100	2,248	18	1,681½	35
Trudeau	0.7	14.2	11.9		23		14		30

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work completed.
	Lin. ft.					
Lopez		Dec. 7, 1892	Mar. 1, 1893	Mar. 9, 1893	Dec. 9, 1892	Mar. 9, 1893
Burtville		Nov. 7, 1892	Mar. 1, 1893	Mar. 30, 1893	Oct. 31, 1892	Mar. 14, 1893
Towles		Jan. 9, 1893	Mar. 1, 1893	Mar. 8, 1893	Jan. 23, 1893	Mar. 8, 1893
Billings		Jan. 9, 1893	Mar. 1, 1893	Mar. 14, 1893	Jan. 6, 1893	Mar. 14, 1893
Jolisant		Dec. 7, 1892	Mar. 1, 1893	Mar. 15, 1893	Dec. 3, 1892	Mar. 15, 1893
Oakley to St. Gabriel	725	Nov. 7, 1892	Mar. 1, 1893		Nov. 14, 1892	Feb. 13, 1893
Dicharry, lower		Oct. 31, 1892	Feb. 15, 1893	Mar. 15, 1893	Oct. 31, 1892	Mar. 10, 1893
Burnside	175	Nov. 7, 1892	Feb. 15, 1893		Dec. 5, 1892	Feb. 13, 1893
Union, upper		Oct. 29, 1892	Dec. 15, 1892	Jan. 12, 1893	Nov. 1, 1892	Jan 11, 1893
Union, lower		Oct. 29, 1892	Dec. 1, 1892	Feb. 4, 1893	Nov. 18, 1892	Jan. 11, 1893
Tippecanoe		Nov. 8, 1892	Jan. 1, 1893		Oct. 27, 1892	Jan. 1, 1893
Peytavin	200	Oct. 29, 1892	Dec. 1, 1892	Jan. 14, 1893	Oct. 31, 1892	Jan. 14, 1893
White Hall		Nov. 14, 1892	Mar. 1, 1893		Nov. 9, 1892	Jan. 14, 1893
Tessier		Nov. 7, 1892	Feb. 15, 1893	Mar. 15, 1893	Dec. 5, 1892	Mar. 10, 1893
Hope		Nov. 5, 1892	Feb. 1, 1893	Mar. 1, 1893	Nov. 2, 1892	Apr. 10, 1893
Trudeau	800	Nov. 5, 1892	Feb. 15, 1893		Nov. 5, 1892	

Name of levee.	Embankment, distance from center of levee to river bank. Min.	Max.	Mean.	Nature of river bank.
	Feet.	*Feet.*	*Feet.*	
Lopez	220	340	310	Washing bank.
Burtville	340	850	600	Sloughing and caving.
Towles	210	270	240	No references as to nature of bank.
Billings	330	490	350	Do.
Jolisant	130	360	230	Caving below low end of levee.
Oakley to St. Gabriel	330	460	400	Sloughing and caving.
Dicharry, lower	600	860	650	Caving bank.
Burnside	180	310	245	Washing bank.
Union, upper	120	210	180	Do.
Union, lower	130	200	160	Do.
Tippecanoe	130	230	170	Do.
Peytavin	170	230	190	Do.
White Hall	350	550	450	Bank making sand bar.
Tessier	380	530	450	Small caves near lower end and crevasse in old levee.
Hope	240	960	600	Caving rapidly.
Trudeau*	240	430	330	Washing bank.

* Work 46 per cent completed when contract expired, February 15, 1893; contractor defaulted.

Fourth district levees, 1892-'93—Continued.

LAKE BORGNE LEVEE DISTRICT.

Name of levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered	Grade of levee above high water of 1892.	Section.		
						Crown.	River slope.	Land slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*		
Slaughterhouse	968.5 L.	Louis Louque	716	720	2½	8	2 and 4 to 1.	2½ to 1
Slaughterhouse Extension.	968.5 L.	.....	1,826	.....	1.0	.....	.....	.....
Roy	960 L.	Louis Louque	1,139	1,110	2½	8	2 and 4 to 1.	2½ to 1
Bonzano	969 L.	....do	683	675	2½	8	2 and 4 to 1.	2½ to 1
Chalmette Cemetery.	969.5 L.	....do	883	880	2½	8	2 and 4 to 1.	2½ to 1
Deboushel	970 L.	....do	698	680	2½	8	2 and 4 to 1.	2½ to 1
Pecan Grove	973 L.	James Byrne	1,466	1,500	2½	8	3 to 1	2½ to 1
Story, upper	974 L.	S. D. Moody & Co	1,308	1,308	2½	8	3 to 1	2½ to 1
Story, lower	975 L.	Robt. McNamara	4,670	4,725	2½	8	3 to 1	2½ to 1
Repose	976 L.	John Cleary	1,454	1,600	2½	8	3 to 1	2½ to 1
Caernarvon	979 L.							
Orange Grove, upper.	980 L.	Philip J. Reilly	4,755	4,720	1½ to 2½	8	3 to 1	2½ to 1
Orange Grove, lower.	980 L.	....do	840	830	2½	8	3 to 1	2½ to 1

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavations.		Tile drains.	
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	Linear yards.	Price per linear yard.
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*		*Cents.*
Slaughterhouse	1.3	4.5	2.5	1,319.93	19 23/100	268.27	17	230.33	50
Slaughterhouse Extension	.4	2.2	1.0	3,037.00	.....	.....	.....	.....	.....
Roy	1.8	7.8	6.9	7,806.22	19 23/100	659.93	17	387.00	50
Bonzano	6.2	6.8	6.5	3,896.03	19 23/100	325.53	17	227.00	50
Chalmette Cemetery	.9	8.5	6.5	4,724.78	19 23/100	387.95	17	294.00	50
Deboushel	8.1	9.5	8.5	6,131.67	18 23/100	375.84	17	251.66	50
Pecan Grove	4.0	9.7	7.5	12,042.00	22½	703.64	22½	(*)	42
Story, upper	2.8	5.6	4.2	5,793.60	24 7/8	700.42	17	(*)	40
Story, lower	2.7	9.7	5.5	42,556.83	30	879.71	20	(*)	40
Repose	7.2	8.9	7.8	11,837.11	23	787.96	20	(*)	35
Caernarvon	.....	.....	.....	.....	.....	.....	.....	.....	.....
Orange Grove, upper	7.7	11.3	10.0	58,521.82	23	1,103.88	20	(*)	44
Orange Grove, lower	6.9	8.2	7.5	6,927.95	23½	397.94	20	(*)	.....

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work completed.
	Lin. ft.					
Slaughterhouse	.....	Nov. 3, 1892	Mar. 1, 1893	.....	Nov. 9, 1892	Jan. 12, 1893
Slaughterhouse Extension.	.....	.....	.....	.....	Feb. 6, 1893	Feb. 23, 1893
Roy	1,139	Nov. 3, 1892	Feb. 1, 1893	Feb. 10, 1893	Dec. 7, 1892	Feb. 9, 1893
Bonzano	683	Nov 3, 1892	Feb. 1, 1893	.....	Dec. 9, 1892	Jan. 31, 1893
Chalmette Cemetery	582	Nov. 3, 1892	Feb. 1, 1893	.....	Nov. 24, 1892	Jan. 31, 1893
Deboushel	698	Nov. 3, 1892	Feb. 1, 1893	.....	Nov. 23, 1892	Jan. 31, 1893
Pecan Grove	1,466	Nov. 7, 1892	Feb. 15, 1893	.....	Dec. 1, 1892	Feb. 10, 1893
Story, upper	.....	Dec. 10, 1892	Mar. 1, 1893	.....	Dec. 23, 1892	Feb. 24, 1893
Story, lower	1,185	Dec. 10, 1892	Mar. 1, 1893	.....	Nov. 30, 1892	Feb. 17, 1893
Repose	1,454	Nov. 12, 1892	Mar. 1, 1893	.....	Nov. 23, 1892	Feb. 17, 1893
Caernarvon	.....	.....	.....	.....	.....	.....
Orange Grove, upper	494	Nov. 8, 1892	Mar. 1, 1893	Mar. 25, 1893	Nov. 22, 1892	Mar. 24, 1893
Orange Grove, lower	840	Nov. 8, 1892	Mar. 1, 1893	Mar. 25, 1893	Dec. 23, 1892	Mar. 22, 1893

Fourth district levees, 1892–'93—Continued.

LAKE BORGNE LEVEE DISTRICT—Continued.

Name of levee.	Name of contractors.	Revetment. Linear feet.	Revetment. Price per linear foot.	Date of contract.	Work commenced.	Work completed.
			Cents.			
Slaughterhouse	Martin & Delaney	716	50	Jan. 12, 1893	Jan. 25, 1893	Feb. 11, 1893
Slaughterhouse Extension.		784				
Roy	Martin & Delaney / W. L. Delaney	1,143	50	Jan. 12, 1893 / Feb. 16, 1893	Mar. 10, 1893	Mar. 29, 1893
Bonzano	Martin & Delaney / W. L. Delaney	682.6	60	Jan. 12, 1893 / Feb. 16, 1893	Mar. 13, 1893	Mar. 28, 1893
Chalmette Cemetery.	Martin & Delaney / W. L. Delaney	877	65	Jan. 12, 1893 / Feb. 16, 1893	Feb. 22, 1893	Mar. 4, 1893
Deboushel	Louis Louque	678.75	69	Jan. 12, 1893	Feb. 15, 1893	Mar. 4, 1893
Pecan Grove						
Story, upper						
Story, lower						
Repose						
Caernarvon						
Orange Grove, upper.						
Orange Grove, lower.						

Name of levee.	Embankment distance from center of levee to river bank. Minimum.	Maximum.	Mean.	Nature of river bank.	Remarks.
	Feet.	*Feet.*	*Feet.*		
Slaughter House	25	90	50	Washing bank.	Enlargement; open space to bank line; straight reach; levee runs along edge of street.
Slaughter House extension.	.....	.....	.....	....do	Enlargement; straight reach; open space to river bank.
Roy	60	120	70	....do	Do.
Bonzano	90	110	100	....do	Do.
Chalmette Cemetery	30	100	80	Washing bank with one large slough near lower end of line which approaches berme of levee.	New and enlargement; straight reach; open space to river bank.
Deboushel	55	110	80	Caving bank...	New; breach of about 125 feet in old levee had occurred before new levee was built.
Pecan Grove	185	235	200	Washing bank.	New and enlargement; concave bank of slight bend; enlargement portion of this levee is protected by willows; new portion by old levee left standing.
Story, upper	120	160	140	....do	Enlargement; straight reach; this levee is protected from wave wash by willows.
Story, lower	160	400	250	....do	New and enlargement; straight reach; this levee is protected from wave wash by willows.
Repose	130	170	140	....do	New; concave reach; open space to river bank; levee is somewhat protected from wave wash by high batture.
Caernarvon	.....	.....	.....	....do	Bids rejected considered too high. See Levee, 1893–'94.
Orange Grove, upper	180	420	300	....do	New; straight reach just below deep bend; new levee protected from wave wash by old levee still standing; willows on batture opposite upper portion of levee.
Orange Grove, lower	120	130	125	....do	New; straight reach, just below deep bend; new levee protected from wave wash by old levee still standing; willows on batture opposite upper portion of levee.

* Supplemental articles of agreement.

Fourth district levees, 1892–'93—Continued.

BARATARIA LEVEE DISTRICT.

Name of levee.	Miles below Cairo and Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section	
						Crown.	River slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*	
Magnolia	980.5 R.	Robert McNamara	5,577	4.875	2½	8	2 and 4 to 1.
Fort St. Leon, upper.	981.5 R.	James N. Ogden	1,854	1,800	2½	8	3 to 1.
Fort St. Leon, lower.	982.5 R.	do	918	900	2½	8	3 to 1.
Belle Chasse Crevasse.	983 R.	do	742	703	2½	8	2 and 4 to 1.
Belle Chasse to Concession.	985 R.	do	9,675	9,600	2½	8	2 and 4 to 1, 4 and 3 to 1.
Concord	987 R.	do	2,544	2,350	2½	8	3 to 1.
Oak Point	988.5 R.	do	2,137	2,000	*2	8	3 to 1.
Live Oak	991.5 R.	do	1,244	1,200	†1 ‡2½	8	2 and 4 to 1.
Happy Point	994 R.	do	965	1,400	*2	8	3 to 1.

† Enlargement. ‡ New.

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavation.		Tile
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	Lineal yards
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*	
Magnolia	2.5	5.8	5.0	28,734.13	25	2,930.57	20	1,905
Fort St. Leon, upper	5.7	8.1	6.7	11,978.13	20	1,335.57	20	838
Fort St. Leon, lower	3.0	7.4	6.0	5,595.83	22	841.91	22	286
Belle Chasse Crevasse	2.5	11.7	7.5	4,035.48	23	334.96	20	271
Belle Chasse to Concession	.7	8.9	5.2	51,546.77	22	2,704.20	22	3,404
Concord	7.0	8.9	8.5	25,046.44	20	1,658.19	20	943
Oak Point	5.3	6.4	6.0	11,314.20	22	1,316.37	22	786
Live Oak	6.9	8.5	8.2	7,587.01	22	531.01	22	326
Happy Point	1.0	8.0	7.6	8,672.94	23	1,027.20	23	500

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Wo p
	Linear feet.					
Magnolia	4,700	Nov. 2, 1892	Feb. 1, 1893	Feb. 20, 1893	Nov. 14, 1892	Feb
Fort St. Leon, upper	1,854	Nov. 14, 1892	Mar. 1, 1893		Nov. 18, 1892	Dec
Fort St. Leon, lower		Nov. 2, 1892	Mar. 1, 1893		Nov. 2, 1892	Dec
Belle Chasse Crevasse	183	Nov. 14, 1892	Feb. 1, 1893		Dec. 15, 1892	Jan
Belle Chasse to Concession	1,057	Nov. 2, 1892	Feb. 1, 1893	Feb. 20, 1893	Nov. 26, 1892	Feb
Concord	2,544	Nov. 14, 1892	Mar. 1, 1893	Apr. 21, 1893	Dec. 22, 1892	Ap
Oak Point	2,137	Nov. 2, 1892	Mar. 1, 1893	Mar. 10, 1893	Nov. 25, 1892	Ma
Live Oak	844	Nov. 2, 1892	Feb. 15, 1893		Jan. 3, 1893	Feb
Happy Point	975	Nov. 14, 1892	Mar. 1, 1893		Dec. 12, 1892	Feb

Fourth district levees, 1892-'93—Continued.

BARATARIA LEVEE DISTRICT—Continued.

Name of levee.	Name of contractors.	Revetment.		Date of contract.	Work commenced.	Work completed.
		Linear feet.	Price per linear foot.			
			Cents.			
Magnolia	W. R. Thompson		65	Jan. 21, 1893		
	Carbolineum Wood Preserving & Manufacturing Co., Limited.	4,239	74½	Feb. 23, 1893	Mar. 3, 1893	Mar. 24, 1893
Fort St. Leon, upper						
Fort St. Leon, lower						
Belle Chasse Crevasse						
Belle Chasse to Concession.	W. R. Thompson			Jan. 21, 1893		Mar. 24, 1893
	O. H. Parsons	8,174	65	Feb. 23, 1893	Feb. 7, 1893	
Concord						
Oak Point						
Live Oak	W. R. Thompson	838	65	Annulled Feb. 22, 1893 Jan. 21, 1893	Commenced by United States Feb. 24, 1893.	Mar. 4, 1893
Happy Point						

Name of levee.	Embankment, distance from center of levee to river bank.			Nature of river bank.	Remarks.
	Minimum.	Maximum.	Mean.		
	Feet.	*Feet.*	*Feet.*		
Magnolia	.....	.....	.....	.....	Enlargement; concave reach; bank slightly caving near lower end of line; batture opposite upper portion grown up with willows.
Fort St. Leon, upper	.....	.....	.....	.....	New; straight reach; open space to river.
Fort St. Leon, lower	.....	.....	.....	Washing bank; sand bar seemingly forming in front.	New; concave reach; open space to river.
Belle Chasse Crevasse	.....	.....	.....	Slight cave during winter, but nothing more than usual wave wash.	New and enlargement; straight reach just below deep bend; batture densely grown up with willows.
Belle Chasse to Concession	.....	.....	.....	Washing bank, but caving in bend above.	New and enlargement; upper portion protected from wave wash by old line; from 57 to 64 of lower section protected by willows; batture opposite all other points is open to new bank.
Concord	230	230	230	Washing bank	Straight reach; old levee from 30 to 40 feet from bank; new levee runs through cane and pea field; open space to river; new.
Oak Point	75	250	230	Slight cave near lower end of line.	New; straight reach; slight cave in bank at lower end of line from 20 to 50 feet from new bank; new levee through pea field; open space to new bank.
Live Oak	310	340	325	do	New and enlargement; washing bank; open space to river; new levee runs through field; upper section, enlargement, is about 90 feet from river bank, and bank shows some tendency to cave; batture is slightly grown with willows.
Happy Point	320	380	350	Washing bank	New and enlargement; new levee runs through field and garden; open space to river bank.

* *Grade made less than 2½ feet above high water, 1892, through error.*

Fourth district levees, 1892–'93—Continued.

SUMMARY.

	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Barataria.	Lake Borgne.
Earthwork.....cubic yards..	522,349.55	445,477.14	393,554.46	503,505.40	167,180.91	168,159.6
Embankment....linear feet..	109,217	17,164	25,363	44,695	25,656	18,611
Axis of river covered.....do.....	56,500	15,780	23,935	42,451	24,828	18,748
Drain tiles.....do.....	7,292½	12,398	22,587	30,804½	27,157	4,199.5
Revetment.....do.....	None.	None.	None.	None.	12,413	4,097.5

GRAND SUMMARY.

Earthwork	cubic yards..	2,200,226.6
Embankment	linear feet..	240,706
Axis of river covered	do.....	219,092
Drain tiles	do.....	104,439.5
Revetment	do.....	16,510.5

In accordance with the approved recommendation of the Commission, made by authority of the act of July 13, 1892, that contracts be entered into for levee work to be paid for from the appropriation for the fiscal year ending June 30, 1894, advertisements were issued and a number of contracts were entered into in anticipation of an appropriation to cover the allotments made for the coming fiscal year. This appropriation was made in the sundry civil act of March 3, 1893.

Contracts have been made for the following levees, the contracts providing that the works are to be completed by June 30, 1894:

Name of levee.	Bank and miles below Cairo.	Name of levee.	Bank and miles below Cairo.
Lower Tensas Levee district:		*Pontchartrain Levee district:*	
Rifle Point	700 R.	Houmas	891 L.
Atchafalaya Levee district:		Hester	908.5 L.
St. Francis Church	798 R.	St. Elmo	910 L.
Belle Vale	825.5 R.	Poche	911 L.
Missouri	840 R.	Terre Haute	921 L.
Dubboine Upper	865 R.	Prospect	936 L.
Belle Grove	870 R.	*Barataria Levee district:*	
Celeste	871.5 R.	Magnolia, new and enlargement	987.5 R.
Mount Salem	872 R.	Fort St. Leon, middle	982 R.
Babin	879 R.	Kearney	983 R.
Lafourche Levee district:		St. Anne, enlargement	984.5 R.
Melancon-Lemanville	893 R.	Oakville	990.5 R.
Jamestown Lower	898 R.	Belle Chasse	983 R.
St. Emma	904 R.	Dobard	992 R.
Magnolia	911 R.	Star	998 R.
White Rose	918 R.	Ironton	1,002.2 R.
Providence	932 R.	Oakland	1,006 R.
Flagtown	936.5 R.	*Lake Borgne Levee district:*	
Speranza	937 R.	Battle Ground, new and enlargement	969.5 L.
Ashton	940 R.	Irving	976 L.
Pontchartrain Levee district:		Caernarvon	979 L.
Shannon Lower	837 L.	Orange Grove	980.5 L.
Maryland	872 L.	English Turn	982 L.
Rescue	874 L.	St. Clair	983 L.
Southwood Upper	874.7 L.	Mon Plaisir	984 L.
Belle Helene	879 L.		

Fourth district levees, 1893–'94.

LOWER TENSAS, ATCHAFALAYA, AND LA FOURCHE LEVEE DISTRICTS.

Levee district and name of levee.	Miles below Cairo, and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section. Crown.	River slope.	Land slope.
Lower Tensas district:			*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Rifle Point	700 R.	J. S. McTighe & Co.	16,974	16,500	2½	8	3 to 1	2½ to 1
Atchafalaya district:								
Belle Vale	825.5 R.	W. J. Bentley & Co.	3,484	.....	2½	8	3 to 1	2½ and 4 to 1.
Missouri	840 R.	Jno. Scott & Son	4,574	.....	2½	8	3 to 1	2½ and 4 to 1.
Celeste	872 R.	W. L. Killebrew	2,888	.....	2½	8	3 to 1	2½ to 1
Mount Salem	872 R.	W. L. Killebrew	2,100	.....	2½	8	3 to 1	2½ to 1
Lafourche district:								
White Rose	918 R.	Jeffries & Damon	1,623	.....	2½	8	3 to 1	2½ to 1
Flagtown	936.5 R.	Andrews Bros. Construction Co.	1,953	1,760	2½	8	3 to 1	2½ to 1
Speranza	937 R.	Andrews Bros. Construction Co.	2,245	.....	2½	8	3 to 1	2½ and 4 to 1.

Levee district and name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavations. Cubic yards.	Filled excavations. Price per cubic yard.	Muck ditch.
Lower Tensas district:	*Feet.*	*Feet.*	*Feet.*		*Cents.*		*Cents.*	*Lin. ft.*
Rifle Point	2.0	7.2	4.8	68,000	15 94/100	.....	15 94/100	None.
Atchafalaya district:								
Belle Vale	0.4	12.8	12.3	71,524.85	16½	211.05	13	58
Missouri	0.8	13.2	12.8	98,816.24	16 38/100	361.71	16 38/100	
Celeste	7.5	10.5	9.9	36,527.20	14 99/100			
Mount Salem	0.8	10.8	9.3	24,944.71	14 94/100	230.36	14	
Lafourche district:								
White Rose	0.7	13.3	9.5	19,248.04	15	63.65	15	
Flagtown	3.2	9.0	7.3	15,415.06	14 84/100	22.44	14 84/100	
Speranza	0.3	12.5	10.5	33,064.40	14 74/100	342.79	14 74/100	

Levee district and name of levee.	Date of contract.	Contract time for completion.	Work commenced.	Work completed.
Lower Tensas district:				
Rifle Point	Feb. 6, 1893	June 30, 1894	.....	.....
Atchafalaya district:				
Belle Vale	Feb. 6, 1893	....do	Apr. 10, 1893	.....
Missouri	Feb. 20, 1893	....do	Apr. 7, 1893	.....
Celeste	Feb. 11, 1893	....do	Mar. 21, 1893	.....
Mount Salem	....do	....do	Mar. 22, 1893	.....
Lafourche district:				
White Rose	Feb. 7, 1893	....do	Apr. 14, 1893	.....
Flagtown	....do	....do	Apr. 8, 1893	Apr. 26, 1893.
Speranza	....do	....do	Apr. 27, 1893	.....

Levee district and name of levee.	Embankment, distance from center of levee to river bank. Min.	Max.	Mean.	Nature of river bank.	Remarks.
	Feet.	*Feet.*	*Feet.*		
Lower Tensas district:					
Rifle Point	2,200	8,000	5,500	Not stated	New and enlargement.
Atchafalaya district:					
Belle Vale	300	500	400	Caving bank ..	On May 31 35 per cent completed.
Missouri	400	750	600	Caving and sloughing.	On May 31 83 per cent completed.
Celeste	360	550	450	Caving bank ..	On May 31 43 per cent completed.
Mount Salem	340	440	395	....do	On May 31 81 per cent completed.
Lafourche district:					
White Rose	270	390	330	Sloughing bank	On May 31 70 per cent completed.
Flagtown	310	410	360	Washing bank.	
Speranza	160	240	200	....do	Work suspended May 3, 1893; 20 per cent completed.

Fourth district levees, 1893-'94—Continued.

PONTCHARTRAIN LEVEE DISTRICT.

Levee district and name of levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section.		
						Crown.	River slope.	Land slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*		
Maryland	872 L.	Alex. Eltringham	4,570	.....	2½	8	3 to 1	2½ to 1
Rescue	874 L.	....do	1,457	.....	2½	8	3 to 1	2½ and 4 to 1; 3 to 1 wing.
Hester	908.5 L.	S. D. Moody & Co., limited.	5,466	.....	2½	8	3 to 1	2½ and 4 to 1
St. Elmo	910 L.	....do	1,812	3,275	2½	8	3 to 1	2½ and 4 to 1
Poche	911 L.	Jeffries & Dameron	2,521	2,710	2½	8	3 to 1	2½ to 1
Terre Haute	921 L.	H. C. Brown	4,347	.....	2½	8	3 to 1	2½ to 1

Levee district and name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavations.		Date of contract.
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*	
Maryland	2.7	10	9.5	53,549.19	$14\frac{73}{100}$	175.91	$14\frac{73}{100}$	Feb. 7, 1893.
Rescue	1.0	13.7	.....	.....	15	.....	15	Do.
Hester	.5	14.4	13.1	122,625.60	$15\frac{1}{2}$	1,356.96	$15\frac{1}{2}$	Do.
St. Elmo	4.0	12.1	11.3	31,764.77	$15\frac{1}{2}$	232.36	$15\frac{1}{2}$	Do.
Poche	1.3	8.8	8.4	24,125.66	15	157.71	15	Do.
Terre Haute	1	9.8	9.1	47,235.23	$14\frac{80}{100}$	263.61	10	Do.

Levee district and name of levee.	Contract time for completion.	Work commenced.	Work completed.	Embankment. Distance from center of levee to river bank.		
				Minimum.	Maximum.	Mean.
				Feet.	*Feet.*	*Feet.*
Maryland	June 30, 1894	May 11, 1893	.....	230	290	2[illegible]
Rescue	....do	....do	....do	450	500	47[illegible]
Hester	....do	May 23, 1893	.....	510	700	60[illegible]
St. Elmo	....do	Feb. 16, 1893	.....	640	670	650
Poche	....do	Mar. 17, 1893	Apr. 13, 1893	150	260	205
Terre Haute	....do	May 9, 1893	....do	210	330	230

Levee district and name of levee.	Nature of river bank.	Remarks.
Maryland	Sloughing bank; no cavings.	Work 2 per cent completed May 31, 1893.
Rescue	Caving bank	Work 20 per cent completed May 31, 1893.
Hester	....do	Work 1 per cent completed May 31, 1893.
St. Elmo	Caving rapidly	
Poche	Washing bank	
Terre Haute	Sloping bank	Work 18 per cent completed May 31, 1893.

Summary for levees built under allotment for fiscal year ending June 30, 1893.

	Levee district.		
	Atchafalaya.*	Lafourche.	Pontchartrain.
Earthwork placed to June 1, 1893 (approximate).....cubic yards..	119,920	42,635	72,166
Embankment completed.....linear feet..	.....	1,953	4,333
Axis of river covered.....do....	.....	1,760	5,985

*No levees completed.

GRAND SUMMARY.

Earthwork placed to June 1, 1893 (approximate).....cubic yards..	234,721
Embankment completed (approximate).....linear feet..	6,286
Axis of river covered.....do....	7,745

Upon the recommendation of this office, submitted March 8, 1893, advertisements for further work under the appropriation for the fiscal year 1894 have been postponed until after June 30, 1893.

In addition to the foregoing work of construction numerous minor repairs to the levee have been made in the way of restoring embankments injured by wave wash and the action of rains, repairing weak places, stopping leaks, clearing of weeds, etc.

Levee construction and repairs by the State and the local levee district organizations have been very active during the year in all parts of the fourth district, except in the Lower Tensas Levee district (fifth Louisiana Levee district), where comparatively little work excepting that under direction of this office has been done.

	Levee district.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Lake Borgne.	Barataria.
Aggregate yardage in levees on Mississippi River, June 30, 1892.	9,392,000	9,292,000	3,752,000	6,079,700	1,370,500	1,226,300
Added by United States to May 1, 1893	522,350	445,500	393,554	503,500	168,200	167,200
Added by others to May 1, 1893	40,000	650,000	636,350	305,600	363,500	138,400
Sum	9,954,350	10,387,500	4,780,904	6,888,800	1,902,200	1,531,900
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	149,300	384,500	456,000	409,600	219,800	79,500
Aggregate remaining May 1, 1893	9,805,050	10,003,000	4,324,904	6,479,200	1,682,400	1,452,400

Percentage of length of existing levee system built to date by the United States.

	Per cent.
Lower Tensas Levee district	47
Atchafalaya Levee district	8
Lafourche Levee district	6½
Pontchartrain Levee district	18
Barataria Levee district	5½
Lake Borgne Levee district	3½
Percentage of total length of existing levee system, fourth district, built by the United States	13½

The following report on high water of 1892 was submitted May 4, 1893:

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 4, 1893.

SIR: I have the honor to submit the following special report on the flood of 1892, in compliance with the Commission's resolution of November 17, 1892:

In general terms the flood of 1892 in the fourth district, as compared with the great floods of previous years, was characterized as follows:

It was unusually late in the season and of prolonged duration, the river maintain-

ing a very high and approximately uniform stage throughout the entire months of May and June. The water reached a height averaging about five-tenths of a foot below the highest previously recorded stage (flood of 1890) in the upper part of the district from Warrenton to Red River Landing.

At Red River Landing the highest stage was about the same as the highest previously recorded, that of 1890. Below that point the actual heights reached exceeded all previous records by from 1 foot to 1 7/7 feet, though the maximum heights were modified at many of the gauge stations by large crevasses.

The weather conditions during the flood were generally favorable, as there were few storms or long periods of high winds. The flood was attributable to unusually heavy and prolonged rainfall, which was general and nearly simultaneous throughout the great basins claimed by the main river and its tributary system.

In the organization for applying the funds available for protecting and maintaining the levees Assistant Engineer Douglas was placed in immediate charge of that portion of the district from Warrenton to Red River Landing, with station at Natchez, and Assistant Engineer W. J. Hardee was assigned to the immediate charge of the portion of the district below Red River Landing. All the steamboats, tugs, quarter boats, barges, and other plant of the district available were utilized in protection work, and in addition the tug *Laurel*, chartered for the purpose, was employed. Such inspectors and other employés necessary were engaged and stationed as their services required, under direction of the assistant engineer in local charge. The general plan of operations contemplated, first, holding all levees built by the United States, so as to relieve the local authorities of the expense of their care; second, rendering such assistance on State levees, by use of floating plant and distribution of material, as was practicable with funds available.

As a general rule all labor and a greater portion of the material required to hold State levees were supplied by the State and local authorities, and these authorities supervised the important work of closing crevasses.

The results may be briefly summarized as follows:

No break occurred in the entire line of levees from Warrenton to Red River Landing, and this was the first serious flood during which the levees were successfully held in that portion of the district. The greatest trouble was experienced on the Lake Concordia levees, extending from opposite Natchez to Bullitts Bayou, a distance of about 17 miles.

Below Red River Landing a total of twenty-five breaks occurred of a more or less serious nature, but all of them except five were successfully closed before any great amount of damage was done.

The Belmont and Sarpy breaks in the Ponchartrain Levee district developed into disastrous crevasses. The Anchor crevasse, also in this district, did comparatively little damage.

The injury resulting from the Story and Villere crevasse, on the left bank below New Orleans, though serious, was only local, except that the New Orleans and Southern Railroad was interrupted.

Particular attention is invited to Assistant Engineer Hardee's report on the methods successfully adopted for closing crevasses and to the sketch herewith. Never before in the history of levee work in this district has there been such a large measure of success in closing breaks as in the flood of 1892.

As to the difficulty experienced in holding the levees, it was principally due to low grade, exposure of the levee to wave wash, or concealed defects in the embankment, usually attributed to crayfish or muskrat holes. There was very little trouble from sloughing of the embankment alone, or from mere deficiency of section, and in only one case was a levee ruptured by the caving of the bank. Low-grade levees were easily held, though of course at considerable expense, by layers of sacks filled with earth, or by driving stakes along the crown, placing boards against them on edge, and backing them with earth. In case of very low levees two parallel lines of boards were put up on the crown and the space between filled with earth. In some cases the levees were raised as much as 3 feet by this method. No break occurred from overtopping of the levee.

Where levees were exposed to wave wash they were maintained by protecting them with wooden revetment, or with sacks filled with earth and laid along the slope near the water surface. With proper attention no break need occur from wave wash.

The greatest source of danger, however, and the one that produced nearly all the breaks, was the existence of holes or vacant spaces in and through the levee near its base, as indicated by serious leaks. The method usually resorted to in these cases was to throw earth, either loose or in sacks, on the river slope of the levee opposite where a dangerous leak might be found. This was sometimes effective, but not uniformly so, as the record of breaks shows.

The principal points of interest, in connection with holding or protecting the

levees during the flood season, which were developed or confirmed by the experience during the flood of 1892 are briefly as follows:

During flood seasons a complete and effective organization to patrol and watch the levees is of great importance, and the most careful vigilance should be exercised during the time of danger.

A sufficient provision of floating plant, consisting of barges for material, quarter boats for workmen, and steam tugs or tow boats, is a most valuable auxillary, and indeed is absolutely necessary to give any chance of success in an attempt to close breaks after they occur. In such cases other means of communication and of transporting material are liable to be absolutely cut off, and everything must be moved by water.

Embankments of comparatively small section, if firm and free from holes and leaks, can be safely held even if deficient in height, and levees of standard section have a larger factor of safety and are less endangered by wave wash or sloughing than is usually supposed.

It is highly important to devise some more effective method of holding a levee which developes weakness from holes or serious leakage near the base than has been heretofore generally applied.

The loss and damage resulting from seepage or general leakage through or under a levee frequently becomes serious even if no break occurs. Finally, it may be observed, that with the completion of the levee system the problem of holding the levees below Red River Landing and providing for the safe and free passage of the water of a flood to the Gulf will perhaps become more serious than has heretofore been supposed, and I believe that the indications are that this problem will demand most careful consideration in the near future.

I deem it proper to add the following copy of a resolution passed by the senate and house of representatives of the State of Louisiana:

"Whereas the flood water in the Mississippi River along the Louisiana front from a combination of unprecedented causes has reached a higher elevation than ever known, and that the levee system in its present incomplete condition, with the exception of a few places which gave way from local causes, has been on the whole made to withstand the said flood; and

"Whereas the success thus far attained has been largely due to the timely aid given by the United States through the allotments made by the Mississippi River Commission:

"*Resolved*, That the thanks of the people of this State be extended to the United States Government for the liberal appropriations made, and also to Engineers Capt. Curtis Mc D. Townsend and Lieut. John Millis, and their corps of civil assistants, E. C. Tollinger, W. S. Brown, H. S. Douglas, and W. J. Hardee, for their individual efforts and energy in rendering timely aid and assistance to the State and local authorities.

"I, George Spencer, assistant secretary of state of the State of Louisiana, do hereby certify that the above and foregoing is a true and correct copy of a resolution passed in the senate and house of representatives of the State of Louisiana at the regular session of the general assembly for the year 1892."

"Given under my signature and the seal of the State of Louisana at the city of Baton Rouge, this 26th day of March, 1892.

[SEAL.]

"GEO. SPENCER,
"*Assistant Secretary of State.*"

I do not consider any further comment necessary as to the manner in which the employés under this office discharged the laborious and exacting duties which the flood season required, except to say that all, including those whose services were not of a character to bring them prominently to the notice of the public, are deserving of equal commendation.

Annexed hereto are the reports of Assistant Engineers H. S. Douglas and W. J. Hardee.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Col. C. B. COMSTOCK.
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

NATCHEZ, MISS., *June 30, 1892.*

SIR: I have the honor to submit the following report on protection of levees, Tensas Basin, fourth district, for the year ending June 30, 1892:

On April 14, 1892, the river had risen to the danger line at Vicksburg (41.0 feet)

and reports of heavy rains and rising tributaries indicated a flood of unusual heigh in the Mississippi River.

Reasonable precaution suggested that preparations for levee protection work i this district should be at once undertaken, and they were. On May 1, 1892, th United States quarter boat *Delta* and barge with outfit of material necessary f levee protection work arrived at Natchez, Miss., in tow of steamer *Newton*. Th United States quarter boat *Gamma* and barge with material and tools arrived Natchez on May 6, 1892.

Some work had been done on Henderson levee (713 R) and Lake Concordia lev (693 R) prior to the arrival of the quarter boats, but the most active and energet steps were at once taken to protect and save the entire line if possible with th means at hand.

The quarter boat *Delta* and barge with the necessary material, tools, etc., and a organized force of trained employés on board, was transferred from levee to leve as the emergency demanded, and rendered very efficient service.

The quarter boat *Gamma* was held at Natchez as an emergency boat available case of disaster, which fortunately did not occur.

As rapidly as possible an efficient corps of inspectors, composed of employés wh had had previous experience on levees in this district, was organized. The inspectors were stationed at such points as seemed to be the most advantageou Although the responsible duty of guarding and patrolling the line of levees was, i accordance with the resolution of the Mississippi River Commission, left to the loca authorities, the territory from Point Pleasant (622.2 R) to Fairview (726.6 R), a dis tance of about 106 miles, was almost daily inspected by a representative of th United States.

The duties of these inspectors were to investigate all places reported to be danger ous when considered necessary to inform the assistant engineer in local charge; t employ the requisite force on United States levees and have such work done as wa required to secure dangerous or weak places, and to attend to the usual routin work of making reports, keeping time of force, and having pay rolls signed.

Considering results, the plan and organization would appear to have reached point approximating perfection, for I have the pleasure of reporting that after a unexpected flood of unusual height and duration not a single break now exists in th line of levees, Tensas Basin, fourth district, a line 135 miles long of the highest, mos dangerous and inaccessible levees on the Mississippi River.

When the exigencies of the service permitted, the assistant in local charge wa provided with a Government boat. At other times he was authorized to charter but under either condition prompt response was made to all calls of assistance i holding the line of levees.

I consider it proper to state that the residents in threatened localities have inva riably rendered willing and efficient assistance service, and to them as well as t the employés of the United States the credit of maintaining the line of levees is due

I give a brief statement of protection work done and the causes thereof, taking th levees in detail from the head of the district to Fairview, the end of the lower line

Bedford Levee (*U. S. 696 R.*).—No protection work was necessary. At this levee th embankment had been reinforced by "banquettes," and no weakness was shown.

From Bedford to Hardtimes-Wilson (*State levees*).—No work of consequence wa necessary and no material was furnished by the United States.

Hardtimes-Wilson Levee (*U. S. 631 R*).—This levee gave no trouble. It is a high grade levee and was not a cause of anxiety at any time.

Hardtimes Levee (*U. S. 633 R.*).—The base of the large dike across the foot of Lak St. Joseph became very soft and threatened to slough. A force was put to work t repair the weakness. As the country in the vicinity was submerged, earth had t be boated on a barge from abandoned levees to secure the levee across the lake. This made the work expensive, but by May 30 all weak places had been permanently repaired. No further work was necessary during the flood.

Evergreen Levee (*U. S. 637 R.*).—No work was necessary.

Hardscrabble Levee (*U. S. 639 R.*).—The original levee withstood the flood, and th water did not come against the new levee of 1891–'92. But little work was required. A few low places had to be raised to prevent the water flowing over, but beyond this no weakness was developed.

Bondurant Levee (*U. S. and State 643 R.*).—But little of the original United State levee remains, owing to destruction by caving banks. No protection work wa necessary.

From Bondurant to Kempe (*all State levees*).—But little work was required, and thi portion of the line was cared for by the local authorities.

Old Kempe Levee (*U. S. 657 R.*).—At the upper end of this embankment several sand boils or crayfish holes caused apprehension. They were checked by a liberal use o sacks. The levee at the threatened point is about 22 feet high.

New Kempe Levee, upper, middle, and lower sections (*U. S. 659 R.*).—This levee wa

completed this year. When the river rose and came against the new embankment, which was composed principally of sand, several incipient sloughs occurred. They were thoroughly and permanently repaired, by reinforcing the embankment on the river side with earth at the threatened points.

From Kempe to Gibsons Landing Levee (all State work).—No protection work was necessary the greater portion of the line having been raised and enlarged by the local authorities since the flood of 1890.

Gibsons Landing Levee (U.S. 683. 5 R.).—This new high-grade levee required but little work. There were some indications of a slough at the upper end, but this weakness was promptly repaired. The great dike across Lake St. John, the largest piece of levee in the district gave no signs of weakness.

From Gibsons Landing Levee to Lake Concordia (all State levees).—Of low grade, considerable work was necessary. Material was furnished by the United States and labor by local authorities.

Lake Concordia Levee (U. S. 693 R.).—This is the worst United States levee in the district. It is of low grade, riddled with crayfish holes, composed of poor material, and exposed to wave wash. It was only held during the flood by the most extraordinary exertions. At times night work was necessary. Five incipient crevasses occurred and were closed. During storms the waves of the lake rolled over the top of the levee for about 5 miles to such a degree that the lands were overflowed and a railroad track partially submerged. In holding this levee, which is about 19 miles long, more material and money was used than on all the other United States levees in this district.

Lake Concordia to Arnauldia (All State levees).—Some work to prevent wave wash and prevent overflow in front of the town of Vidalia was done, the United States furnishing material and labor being paid for by local authorities.

Arnauldia Levee (U. S. 709 R.).—No work was necessary.

Arnauldia to Henderson (all State levees).—Some work was done by the local authorities. At the highest stage of the river there were several low places that were seriously threatened.

Henderson Levee (U. S. 713 R.).—At an early date of the flood this levee commenced to slough on the upper wing. Prompt action was taken and the weak points effectually repaired and strengthened.

From Henderson to Greens to Fairview (all State levees).—This is a stretch of low-grade levees, and but for protection work done would have been overtopped by the flood. Considerable work was necessary; the United States furnishing material and the local authorities paying for the labor.

Greens to Fairview including as loop Deer Park Levee (U. S. 725 R.).—With the exception of the Deer Park loop this is a low grade levee and would have been overtopped by the flood but for work done. Protection work was necessary at several places on account of lack of height or incipient sloughs.

The material used for protection work has been confined to sacks of which 26,000 have been used, distributed as follows:

	Sacks.
Hardscrabble	1,000
Kempe	3,000
Kempe to Lake Concordia	3,000
Lake Concordia	15,000
Lake Concordia to Arnauldia	500
Henderson	1,000
Hendersons to Greens to Fairview	1,000
Greens to Fairview including Deer Park	1,500
Total	26,000

The river reached to danger line (41 feet) at Vicksburg, April 14, 1892, and on June 30, 1892 is 46.6 above it, a period of seventy-seven days. On May 10, 1892 the flood reached 48.4 on the Vicksburg Gauge, only seven-tenths below the high-water mark of 1890. It continued without variation at this stage until June 4, 1892, a period of twenty-four days. At Natchez, on June 26, the gauge read 48.10 feet, only 0.5 foot below 1890, and the river reached and remained above the 48-foot stage from June 21 to 29, inclusive, a period of nine days.

Considering the duration and height of the flood of 1892, the strain on the levees has been almost unprecedented, but not a single break now exists in the 135 miles of levees comprising the Tensas Basin, fourth district.

The foregoing data is, I believe, sufficient to indicate what has been accomplished in the line of protection of work on levees under my local charge.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Lieut. JOHN MILLIS,
Corps of Engineers, U. S. A.

REPORT OF MR. W. J. HARDEE, ASSISTANT ENGINEER.

BATON ROUGE, LA., *July 15, 1892.*

SIR: I have the honor to submit the following report upon protection of levees below Red River for the flood period of 1892:

When the usual period of high water was reached the river was well within its banks and there were no indications that an extreme flood would be experienced. Towards the end of April the river commenced rising, and steadily increased in elevation until maximum heights were reached at respective localities as indicated in the following table:

Locality.	Distance between.	1890.		1892.		Difference.
		Date.	Reading.	Date.	Reading.	
	Miles.		*Feet.*		*Feet.*	*Feet.*
Red River Landing	.....	Apr. 23	48.80	June 27	48.87	0.07
Bayou Sara	34.7	Apr. 21	41.20	June 28	42.25	1.05
Baton Rouge	33.5	Apr. 21	36.75	June 28	38.45	1.70
Plaquemine	20.5	Apr. 22	31.90	June 28	33.40	1.50
Donaldsonville	32.2	.....	.....	June 13	30.15	.....
College Point	17.8	Mar. 16	23.90	June 13	25.40	1.50
Carrollton	53	Mar. 17	16.10	June 13	17.26	1.15
Fort Jackson	82.2	.....	.....	June 16	6.60	.....

Frequent inspections were made of the United States levees. They were in excellent condition and did not require the presence of anything like organized forces to look after them. During the latter days of the flood, as a result of the water having stood so long against them, some became saturated and showed a disposition to slough. To correct this a small drainage ditch was excavated in the rear of all portions of the Gay to Hollywood, Woodstock, Hermitage, Ashland to Linwood, Dicharry and Tessier section of Tessier Bourgeois levees. In addition to this ditching the only other work found to be necessary was the construction of about 1,500 feet of rough plank revetment backed with earth laden sacks at the Mayflower Union Levee to check the wave washing of the front slope of that levee at an exposed point.

Prior to 1890 there was in existence 16.4 miles of levee south of Red River which was all the levee that had been wholly or in part built by the United States up to that date on that portion of the river and which length formed a portion of the levee system. After the flood of 1890 the State and local authorities adopted for the standard of future levee building a section designed to have an elevation from 2.5 feet to 3 feet above the high water of that year, and an 8-foot crown with side slopes of 3 to 1 on both sides.

The Atchafalaya Basin Levee Board, a local organization in pursuance of a general plan adopted by it, enlarged 13.4 miles of levee originally built by the United States to conform to the new standard. The Stewarts Crevasse Levee (791.5 feet), measuring 0.6 miles was abandoned by construction of a new line.

All levees built by the United States since 1890 were likewise built to the new standard. To the fact that these levees were so small well above the high water of 1892 and had so wide a crown and base is due the small amount expended to care for them and not to any particular excellence of construction or individual merit possessed by them as compared with lines built by other parties.

There were 37.6 miles of levee built wholly or in part by the United States below Red River, and the small amount of $897, which includes labor and material, was all that was necessary to expend to maintain and keep in good condition that length of line during the recent flood.

The same can be said relatively of all the levees built since 1890 by both State and local authorities. There was an occasional increase of expenditure for protection made necessary at localities where the work was new and exposed, at which places board or sack revetments were constructed. Where the levees were not of standard section immense sums were expended to maintain them. Much of the large amount of money expended was used in raising the low lines of levees. Owing to the unprecedented height reached by the flood the water would have overtopped many miles of the levees on both banks but for such raising. Long lengths of levee were from 0.5 to 1.5 feet lower than the extreme flood elevation and had to be raised to keep the water from running over the tops. The general plan to secure this result was accomplished by driving perpendicular pieces, usually 2 by 4 inches, into the top of the levee at intervals of about 5 feet. To these pieces inch planks were nailed in horizontal position to form a wall to serve the double purpose of breaking the waves and to retain in position the sacks of earth placed behind it. The extent of the "walling" and "sacking" was determined by the height to which the work had to be brought. In some places where as much as 2 feet of raising was necessary, a line of "walling" was also erected in the rear, forming a box as it were to hold sacks and earth.

Work of this character having to be executed at all hours of night and day as well as in all kinds of weather, was necessarily expensive. To show the expensiveness of this work may be cited the case of the Burtville Levee (847.3 L), which was too low and of insufficient section, and though less than 1,500 feet long, something like $7,200 was expended in strengthening and holding it.

There are no means of obtaining actual cost of the protection work on the 501 miles, which includes both banks below Red River, as the work was done by and through so many agencies. From observation and careful consideration of the subject I should estimate $190,000 to be a conservative approximation of the cost of the protection work proper. This estimate does not include the amounts expended in closing crevasses.

The assistance rendered the local authorities by the United States was confined to delivery of lumber, sacks and nails, and the service of boats in towing materials and labor.

The following tabular statement shows the amounts of material expended, localities, purpose, etc.:

Locality.	Distance below Cairo.	Lumber.	Sacks.	How used.
	Miles.	*Ft., B. M.*	*No.*	
Red River Landing*	766 R.	30,000	600	Bulkhead to check sloughing
Nina*	800.5 R.	.....	200	Checking wave wash.
Burtville	847.3 L.	.....	3,500	Do.
Mayflower-Union*	853 R.	4,360	2,450	Do.
Ascension	882.5 R.	30,500	.....	Closing crevasses.
Hermitage	886.5 L.	26,100	5,000	Do.
New Hope	897 R.	21,232	3,000	Do.
Delogny	906.5 R.	54,651	2,500	Do.
Tessier	909.7 L.	20,000	10,000	Do.
Anchor	929.6 L.	25,000	.....	Cribs to hold end.
Villere	972 L.	11,015	300	Stopping crayfish leaks.
Corinne	972.5 L.	.....	1,750	Do.
Pecan Grove	974 L.	5,479	1,000	Raising and stopping leaks.
Sakenholm	974.5 L.	5,479	.....	Do.
Repose	976 L.	1,006	.....	Stopping crayfish leaks.
Merritt	976.5 L.	5,051	.....	Do.
Bank	977 L.	1,000	.....	Do.
Poydras	977.5 L.	8,056	.....	Do.
Caernarvon	978.5 L.	16,181	.....	Do.
Belle Chasse	983.5 R.	.....	5,000	Closing crevasse.
Searsdale	984 L.	6,009	.....	Stopping crayfish leaks.
Concession	985.2 R.	11,813	1,000	Stopping wave wash and leaks.
Lilly	986 R.	.....	2,000	Stopping leaks.
Augusta	989 R.	2,000	2,000	Raising and stopping leaks.
Cedar Grove	989.5 R.	7,386	3,000	Raising.
Oakville	990 R.	1,000	2,500	Stopping leaks and wave wash.
Star	994.2 R.	.....	100	Stopping wave wash.
Bayhi	997 R.	.....	1,000	Stopping leaks.
La Ruisite	998 R.	.....	1,000	Do.
Monsecour	999 L.	16,198	.....	Do.
Myrtle Grove	1,001 R.	.....	1,000	Do.
St. Sophie	1,002 R.	13,082	1,000	Stopping leaks and wave wash.
Wood Park	1,002.2 R.	.....	1,000	Do.
Harlem	1,003 R.	30,284	5,000	Stopping leaks and closing crevasse.
West Point-a-la-Hache	1,012 R.	.....	1,000	Stopping leaks.
Riceland	1,016 R.	.....	1,000	Do.
Jane Butler	1,017.5 R.	.....	3,000	Do.
Texas Settlement	1,030 R.	.....	1,000	Do.

* United States levees.

In addition to the United States boats the tug *Laurel* was chartered. The boats were used in making inspections, moving materials, towing barges, etc. They rendered particularly efficient and valuable assistance at the crevasses where they moved men and material. The principal service was where they moved loaded sacks from where they were filled to the point at the crevasse from which they were transferred to the crib work.

The service of the boats was as follows:

	Days.
U. S. steamer *General Newton*	17
U. S. steamer *Ruby*	13
U. S. tug *Tilda*	51
Tug *Laurel* (chartered)	50½
Five United States decked barges	35

Despite the large expenditure of money and the unremitting and indefatigable efforts of the local levee organizations, assisted by the riparian owners and residents, disaster could not be averted and a number of breaks occurred, the details of which will be found in the following tabular statement:

Tabular statement of crevasses, compiled from data collected between July 8 and 12, 1892.

Name.	Distance below Cairo.	Date of occurrence.	Cause of crevasse.	Size of levee.			Water below top of levee at time of break.	Maximum width of crevasse.	Approximate maximum of discharge per second.	Crib work.		Water against crib.			Date of closure.	Closing.	Approximate cost of closing.
				Height.	Crown.	Base.				Length.	Average width.	Maximum.	Minimum.	Average.			
	Miles.	1892.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	1892.	*Hours.*	
Ascension	882.5 R.	June 6	Crayfish hole	8.2	6.6	41	−1.4	148	17,200	593	24	8	4	5.2	June 9	57	$10,000
Hermitage	886.5 L.	June 21	....do	7.8	5.4	36	−2.4	63	9,500	516	14	5.5	2.5	4	June 23	49	6,800
New Hope	897 R.	June 1	....do	8.8	4.6	51	−1.2	160	19,100	452	26	9	3	4.2	June 6	132	12,500
Delogny	906.5 R.	June 23	....do	7.8	5.6	54	−1.6	126	16,400	563	30	8	4.6	5.4	June 28	118	13,100
Belmont	908 L.	June 12	....do	10.5	6.5	58	−0.9	1,427	139,846								
Tessier	909.75 L.	May 22	....do	8.1	6	52	+0.6	204	25,520	473	30	10.6	5.5	7.4	May 29	171	19,800
Anchor	929.6 L.	May 16	Unknown	8.2	3.5	47	−2.8	396	21,000								
Sarpy	937 L.	June 13	Crayfish hole	10.2	8.5	64	−0.8	1,380	115,920								
Avondale	952 R.	June 13	....do	10.4	6	58	−1.3	139	16,120	604	37	7	3	4.5	June 19	146	13,700
Villere No. 1	972 L.	May 3	....do	5.5	4	32	−0.5	15	742	46	5	4	2.5	3	May 4	20	245
Villere No. 2	971.9 L.	June 11	....do	5.5	4	32	−0.5	124	1,816								
Story No. 1	975 L.	May 28	....do	7	5	38	−1.2	23	952	181	7.5	7	4	5	May 30	46	710
Story No. 2	974.75 L.	June 11	....do	7.6	5.4	38	−0.8	114	16,560								
Merritt	976.5 L.	June 13	....do	7.4	6	44	−2	96	13,500	510	7	8	2	4	June 19	142	3,900
Belle Chasse	982.5 R.	June 3	....do	7	5	42	−1.2	107	14,186	808	14	4.5	2.5	3.5	June 15	290	5,700
Cedar Grove	989.5 R.	May 24	Old rice flume	4	3	18	+1.2	26	686	120	7	4	2.5	3	May 28	92	450
Belair	995 L.	May 24	Crayfish hole	8.2	5	43	−1.4	62	8,700	1,406	11	6.5	2	3	May 28	90	4,700
Monsecour No. 1	998.9 L.	May 11	....do	6.5	6	32	−1.6	24	2,100	245	5	4	1.5	2.5	May 11	18	325
Monsecour No. 2	999 L.	May 29	....do	6.5	6	32	−1.6	26	2,280	227	7	4	2.5	3.5	June 4	142	375
Happy Point	993 R.	May 18	Rice flume	4.6	8	26	−1	51	6,750	227	14	8.5	3.5	5	May 28	138	2,275
Monsecour No. 3	999.1 L.	June 7	Crayfish	6	6	32	−1.6	37	2,785	193	5	4.5	3	3.5	June 18	260	400
Harlem*	1,002 L. to 1,003.2 L.	May 12 to June 10	Muskrat and crayfish holes, and rice flume.	6	4	26	−1	441	22,050	1,280	8	6	2	4.5	May 15 to July 1	.....	7,200
Miller	1,011.7 L.	May 31	Muskrat	4.4	4	19	−0.6	39	5,985	161	7	4.4	2	3.8	June 14	360	660
Octave	1,012 L.	May 14	....do	4.6	3.5	20	.....	35	5,600	186	6	4.8	2	4	May 14	20	360
Martin	1,013.5 L.	June 26	Caving bank	4	6	26	−1.4	194	3,492	394	2	3	2	2.5	July 2	140	425

*In a distance of 6,000 feet there were 11 breaks at Harlem, and figures presented are aggregates.

At Belmont a large force amply supplied with material started to work within a few hours after its occurrence to try and close the crevasse. The break occurred at 9 p. m. The batture or space between the levee and the river bank was about 100 feet wide. By daylight a deep channel had washed through this batture. The ends of the levee washed rapidly, and in a few hours receded to the points where the line of crib work had been started. The break was considered hopelessly a crevasse and abandoned.

It was not considered impossible but impracticable to close the Anchor Crevasse. The levee is located in the midst of a thick growth of willows and about 700 feet back from the river bank. Though of sand the levee showed no disposition to wash rapidly, owing to the effect produced by the willows on both sides of it. Those on the river side served to check the flow, while those on the land side caught the discharging waters and banked them up, thus decreasing the slope of the throat of the crevasse, and so reducing the draft as to destroy much of its erosive force, resulting in slow enlargement of the break.

The major portion of the discharge sought an easy and but little obstructed passage to Lake Pontchartrain, 5 miles distant through the channels created and left by the Bonnet Carre Crevasse of 1874. In consequence of this the water did not spread north of the crevasse at all, and only to a small extent below, submerging but about one-half the plantation adjoining it and barely touching the rear edge of the cultivated land on the next place below.

The tracks of both the Louisville, New Orleans and Texas Railroad and the Illinois Central Railroad are well removed from the break, neither being nearer than 2 miles, and both were but slightly affected by the break.

The interests affected were too small to justify the expenditure necessary to close the crevasse, which would have amounted to a large sum on account of the location of the break and the inaccessibility of earth with which to fill sacks. It was considered advisable, however, to build a crib spur extending at an angle of about 60° from the levee on both sides of the crevasse to protect the ends from washing. The United States contributed to this work. The railroad authorities at a later date built a strong line of cribbing all the way around the break on the front side. The willows were then cut and allowed to float against the cribbing, making a "drift jam." This not only controlled the further enlargement of the crevasse but served to decrease the discharge fully 30 per cent.

At Sarpy a large force promptly started the work of closing, which was feasible, but at a cost probably of something like $30,000. Work was continued and good progress was made up to the time Belmont Crevasse was declared abandoned. The railroads then withdrew their forces and assistance, and the crevasse was abandoned for want of money to do the work.

Of the thirty-five crevasses four were above New Orleans on the right bank and were all closed. Below New Orleans there were three on the right bank, all of which were closed. Five were on the left bank above New Orleans, of which two were closed. On the left bank below New Orleans, twenty-six, of which twenty-four were closed.

The actual loss of levee by crevasses was 5,457 feet. At the breaks which were closed 2,016 feet of levee was washed away, having a value of less than $5,000. To stop the flow of water through that length of opening about $103,625 was expended.

Crevasse closing.—Never before in the history of levees and crevasses was so much success achieved in closing breaks as during the flood of 1892.

Below New Orleans the levees are small and usually built of stiff clay, the soil of the country being of that general character. There is at all points a wide space of batture between the levee and the river bank, generally covered by a thick growth of willows. The battures are annually elevated by deposit from the river, and it is often times the case that a levee will be 7 feet high on the land side and less than 3 feet high on the river side. To a combination of these facts is due the absence of large crevasses in this section of the river and the promptness and small cost attending the closing of them. Though many of these breaks, where allowed to run for weeks, they never enlarge beyond the size acquired within a few hours after occurrence, owing to the general stability of the earth comprising the levee and surrounding ground.

Above New Orleans, however, the conditions are rather the opposite. There the levees are large, the battures narrow and low, and both the levees and banks are composed of unstable material.

During the flood of 1892 larger crevasses were closed than ever known before under a rising river and more adverse circumstances than had ever been encountered previously on similar work.

It is impossible to close any crevasse where the ends wash away and the break widens rapidly or the batture scours fast. As a general thing such does not follow in less than sixty to seventy-five hours after the break occurs, so that success, even where labor and material is forthcoming, is certainly dependent on expedition.

To the interest manifested by the recently created levee boards and railroads and the assistance rendered by them in promptly responding to the call of the planters is due the principal success of the crevasse closing.

The appended drawings, showing location, side, front, and ground elevations, serve to illustrate the general plan employed in closing the crevasses.

The plan has been studied out and the drawings are presented as an ideal plan and fulfilling all the requirements.

Very few of the cribs were constructed in strict accordance with it, owing to lack of organization and confusion attending the construction, working at night without sufficient light, inexperienced labor, absence of exact-size timbers, and a lack of knowledge of the strength required, and a desire to make sure of same.

At some localities there was a remnant of old levee in front of and parallel to the line in which was the break. The plan at such places was to close the crevasse on three distinct lines, utilizing the remnant of old levee as one and connecting it and new levee with lines of cribbing above and below the break.

The general plan was as shown on diagram, and consisted of a circular line of crib work around the break on the river side.

The ideal plan is to construct the cribs of a width ranging from 4 to 5 feet and when completed to have three times as much base as there is depth of water against the cribbing. The principle of the cribs is to form compartments in which to deposit the sacks and is essential to retain the sacks exactly where desired. The very lightest cribbing that will accomplish this purpose should be constructed, for the strength of the cribbing figures to but a small extent after it is filled with sacks, the mass of sacks affording the necessary lateral strength by virtue of its own weight. There is, on the contrary, great objection to driving any more timber into the batture than is absolutely necessary, for the reason that each piece driven breaks and loosens up the soil, thereby disturbing and causing it to wash, on the maintenance of which so largely depends the success of closing the crevasse.

The correct method of sacking the cribs seems never to have been properly understood heretofore, but was developed at the Tessier Crevasse and operated successfully at the subsequent breaks.

As soon as an obstruction is offered to the passage of water through a crib, as when some sacks are thrown into it, there is immediately produced a miniature cataract or overfall of water from out of it into the next crib behind. This is the destructive agency and must be controlled. It is accomplished by starting at the levee on each side and sacking the rear or inside crib about 1 foot high until the two forces meet. The overfall produced by this line of sacking will be harmless for it will strike the ground well in the rear of the foot of the timbers and any erosion there will not weaken the cribbing. When the rear line has been sacked all the way across, the forces are put in the adjoining crib and it filled about 1 foot higher than the first. The overfall in this crib will be caught by the sacks in the one behind it, and falling on the sacks, which it can not disturb, there will be no erosion, and consequently no weakening of the crib work. This process is carried on continuously until the front crib is reached.

If the height of that "stop" is lower than the surface of the water, fall back into the first crib and sack it and bring up each of the other cribs a little higher in turn until the front crib is brought up above water and it has been entirely shut off.

This method does not close the water off entirely at the ends first, and as they are brought together forcing the flow through a narrow channel and producing such scour as to destroy and wash out the cribbing. It on the contrary reduces that force to a minimum, besides building base in proportion as the pressure increases.

When the sacking has been completed there is more or less leakage through it. To cut this off entirely a line of sheet piling, composed of 1-inch by 12-inch boards, is driven perpendicularly or at slight inclination with a hand maul about 12 or 15 inches in the ground about 6 or 10 feet (according to height) in front of the cribbing. This is tied to the cribbing with lateral bracing. It is filled with earth and tamped and called a "mud box."

Very respectfully, your obedient servant,

W. J. HARDEE,
Assistant Engineer.

Lieut. JOHN MILLIS,
Corps of Engineers, U. S, A.

LOCATION OF LEVEES, GRADES, AND SECTIONS.

The general question of the most judicious location for the new levees in this district, particularly in the case of those below the mouth of Red River, has been a perplexing one, and the proper grades and sections to be adopted present problems scarcely less simple than the matter of location. Any attempt at a theoretical analy-

sis of these questions involves such a multiplicity of conditions, many of which are variable and indeterminate, as to lead to great complications and to result in no definite conclusions of general or practical value.

To deduce theoretically the most judicious and economical location for a levee would involve consideration of the following conditions: The present cost of the new work; the probable cost at the time it might become necessary to renew it; the extent of immediate damage to private property; the value of products of land sacrificed; the probable life of the new levee, which is determined by present caving of bank and probable rate in future; the exposure of the levee to the destructive action of wave wash and of crayfish; and in many cases numerous other conditions peculiar to the locality. When to the above are added the objections and prejudices of property holders and questions of policy which not infrequently have to be considered, it will be understood that theory or fixed rules are of very little assistance in determining the location of a levee, but that the problem is one to be solved mainly by tact and judgment, based on experience and a full knowledge and careful study of all the conditions in each individual case.

The grades to which the new levees are to be built is a matter of great importance, not only as affecting their stability during high water, but as determining the length of embankment that can be built with a given amount of money, as will appear when it is remembered that the cost per unit of length increases approximately as the square of the height. No absolute standard or grade has yet been adopted in this district, either by this office or by the State engineers, but it has been customary heretofore to build to a grade of from 2½ to 3 feet above the highest previously known water, though in certain special cases a higher grade has been adopted in State work. Since the "highest previously known water" is subject to change with each season's flood and appears to be constantly increasing as the levees are made more nearly perfect, this is at best a variable and uncertain standard.

By the time the allotments for levee work under the appropriation of July 13, 1892, finally becomes available it was urgently necessary to get a large amount of work under way at the earliest practicable date, in order to close crevasses, strengthen weak places, raise deficient levees to a height which the flood of 1892 showed would be necessary, and apply the entire amount available so as to get the benefit of it during the succeeding flood season.

In order to comply with the instructions of the Commission it was also necessary to advertise and enter into contract for a considerable portion of the work under the allotment for the fiscal year 1894. The work consisted of a large number of small detached pieces of levee, scattered over the greater portion of the entire district, and it was necessary to adopt some grade which would at least approximate to the requirements, but which had to be determined in the absence of detailed information and without sufficient time to attempt a careful analysis and study of the subject, in order to get the work under contract without delay.

The considerations which determined the grades adopted may be briefly stated as follows: In the flood of 1892 the entire levee system of the lower Tensas District was successfully held without crevasses for the first time. The same was true of the Yazoo Basin levees on the left bank above, while there were several breaks in the Upper and Middle Tensas Basin districts on the right bank, the water from which flowed down the Tensas Basin, and could not reënter the Mississippi above the mouth of the Red.

The relative flood heights in the Lower Tensas Basin in 1892 might therefore be fairly assumed as normal. The absolute height which the water attained at Vicksburg was 0.7 foot less than the highest recorded in the great flood of 1890, but since there were several crevasses in the Yazoo Basin system this year, the water from which returned to the Mississippi in the vicinity of Vicksburg; the actual height reached may have been greater than would have been the case if the Yazoo Basin levees had held as they did in 1892, and it was considered that the weak condition of the levees in the Upper and Lower Tensas districts on the right bank might reasonably be depended upon to restrict the height at Vicksburg in succeeding great floods for a number of years.

At the mouth of Red River the flood height in 1892 was the same as in 1890, and below that point the heights reached in 1892 exceeded all previous records. The flood heights below the Red were, however, modified by two large crevasses, the Belmont and Prospect, but these were in the lower portion of that section of the river between Baton Rouge and New Orleans, where the total annual variation in the height of the river is less, and where the absolute increase in flood height in future may consequently be expected to be less than in the upper portions. Below New Orleans numerous small crevasses took place in 1892, so that the actual height reached must have been generally less than the normal. While the total variation and the increase in flood heights to be expected with the completion of the levees is still less below New Orleans than in the lower portion of the La Fourche and Pontchartrain districts, and the net height of the levees is less, the greater exposure of

the lower river to storms and the frequent passing of large ocean steamers renders the embankments more liable to injury by wave wash, and a somewhat greater relative excess in height above the flood level of the river is desirable, even when they are protected with revetments.

The State authorities have in general adopted a net grade of 3 feet above the highest known water, but their system of inspection and requirements as to gross grades to provide for shrinkage are necessarily somewhat less rigid than is practicable in the case of work done by the Federal Government.

There are several objections to adopting at this time a very high grade. The length of levee that can be built with a given sum rapidly diminishes with an increase in height, and there is manifestly no advantage in building comparatively short detached pieces of levee of great length so long as so large a proportion of the levee system is in such a condition that it must give way long before the water can reach a height to tax the new work to anything like its full resisting power. Experience shows that a sound and properly constructed levee with good width of crown can be successfully held by temporary work in case of emergency against a flood 2 feet or more above its crown, though of course such a deficiency of grade is not to be considered safe. On the other hand it may be said that for levees on a permanent location it is less expensive to build them at once to the maximum grade that will probably be necessary than to stop short at that grade and raise and enlarge them afterwards. This would be true if the cost of levee work was to remain a constant quantity, but it is a constantly decreasing one and likely to continue so for some time to come.

As a practical approximation to the conditions above outlined a net grade of 2½ feet above the flood of 1892 was adopted for the work of last season in all portions of the district. This grade makes the work done by this office at least equal in strength and efficiency to the larger part of the State levees, and it enables the greatest length of levee to be built with funds available that is consistent with safety. It is believed that for a long time to come the new levees built to this grade will have an excess of grade and a very large excess of strength and endurance over the major portion of the levee system, and that when the time comes for providing some means for definitely limiting the flood height of the lower river it will be found that the policy of adopting moderate grades at this time was not inconsistent with efficiency and economy.

As to the form of cross section for levees a great variety has been used in previous years in this district, but at the beginning of last season's work the section that had been generally adopted, both by the State engineers and by this office, had a crown width of 8 feet and side slopes of 3 base to 1 perpendicular. For levees having a net height of over 10 feet the land slope was often made less steep than 3 to 1, and in many cases a banquette, with horizontal top 20 feet wide or more, was built on the land side as a reënforcement, but all slopes were made continuous.

With a view to a reduction in cost and an increase in efficiency the subject was revised at the beginning of last season's work, and the sections adopted for this district are described as follows:

Where levee not exposed to serious wave wash and where permanent revetments are not required:

For average net height of 5 feet or less.—Normal section: Crown width, 6 feet; river slope, 3 to 1; land slope, 2 to 1.

Where conditions are less favorable than average: Make land slope less steep, limit 3 to 1; crown width and river slope same as normal.

Where conditions are more favorable than average: Diminish crown width, limit 4 feet; river and land slopes same as normal.

For average net heights from 5 to 10 feet.—Normal section: Crown width, 8 feet; river slope, 3 to 1; land slope, 2½ to 1.

Where conditions are less favorable than average: Make land slope less steep, limit 3½ to 1; crown width and river slope same as normal.

Where conditions are more favorable than average: Diminish crown width if net height less than 8 feet; river and land slopes same as normal.

For average net height of 10 to 15 feet.—Normal section: Crown width, 8 feet; river slope, 3 to 1; land slope, 4 to 1 up to 5 feet below crown, then 2½ to 1 up to crown.

Where conditions are other than a fair average special instructions will be given.

For average heights from 15 to 20 feet.—Normal section: Crown width, 8 feet; river slope, 3 to 1; land slope, 6 to 1 up to 14 feet below crown, then 4 to 1 to 7 feet below crown, then 2½ to 1 up to crown.

Where conditions are other than a fair average special instructions will be given.

For average net heights exceeding 20 feet.—Instructions will be given.

Where levee is exposed to serious wave wash and material is such as to require permanent revetments:

For average net heights from 5 to 10 feet.—Normal section: Crown width, 8 feet;

river slope, 4 to 1 up to 4 feet below crown, then 2 to 1 up to crown, the upper slope to be protected by board revetment; land slope, 2½ to 1.

Where average net height is less than 5 or more than 10 feet and where conditions are other than fair average special instructions will be given.

The material found in levee work in the fourth district consists of clay or "buckshot" and fine sand, varying in proportions. Pure sand or earth consisting of a very large proportion of sand is not often met with in this district, but clay with a very small portion of sand occurs not infrequently. Well-defined layers of sand and clay are rare.

Besides withstanding the direct pressure of the water during high river the levee embankment must resist the deteriorating influences of the weather and fulfill a variety of other conditions. These conditions impose upon it a form and dimension which give it a large excess of stability when considered merely as a wall or barrier exposed to the side pressure of the water and prevented from overturning by its own weight and from yielding laterally by friction on its own foundation, so that an analysis of these forces is of no value in discussing the subject of section. As a matter of practical experience the causes of a levee yielding or failing are as follows: The embankment sloughs or slides down, caused by penetration of water and a softening and increase in weight of the material so that the particles become disassociated and the material flows or "sloughs" under the action of gravity.

Holes and leaks through or under the embankment may become enlarged by the scour of water flowing through in high water, so that finally the levee breaks. Such holes are due to defective foundations or to crayfish or other burrowing animal.

The embankment may be washed by the action of the waves in high water and breached at the top, thus starting a flow which enlarges the opening and develops a crevasse.

Sandy material is liable to be washed and cut by the action of rain. This in some cases has resulted in such injuries as to call for special devices to prevent it.

Of the above, sloughing and weakness due to the leaks are the most serious and difficult to remedy in high water.

In considering the slopes to be adopted, long experience has shown that a 3 base to 1 perpendicular is practicably stable for the river side of the levee. Although this slope is more liable to become soft than the land slope, it has the support of the water to assist in sustaining it and the river side of a levee built on this slope rarely if ever sloughs even on high embankments. On some accounts a broken or hollow slope would be advantageous for the river side, but these advantages are offset by the greater liability to wave wash during high stages, if the upper part of this slope were made steeper than the lower.

A uniform slope of 3 to 1 has therefore been adopted for the river side of all levees not revetted.

For the land side, in the case of levees of small height, a somewhat steeper slope has been found to be permissible, and this slope is made, under favorable conditions, as steep as 2 to 1, with a view to as great economy as is consistent with strength. With greater heights, however, there is an increased tendency to slough on the land side due to the longer periods during which the water is liable to be against the lower part of the levee, the greater pressure and increased tendency to become soft at the base of the rear slope, and the increased weight of earth above. A broken slope has therefore been adopted for the land side of high levees, which is comparatively steep towards the top and very flat at the base. It approximates to the form which the land side of a sloughing levee assumes. All these slopes are of an inclination which resists the eroding action of rain wash with fairly good material and permits the growth of grass.

Assuming that the distance to which water penetrates into the embankment is proportional to the pressure and depth below the surface, a levee section might be designed by starting with a sufficient width of base to resist the pressure at that point and to permit side slopes not steeper than experience has shown to be necessary, and to give the section a triangular shape with a height equal to the flood height of the river. This would give a thickness of earth everywhere proportional to the depth and pressure, but would manifestly be impracticable without a certain excess in height above the highest water to be expected, to insure a proper degree of safety.

But even such excess in height would not be long maintained in case of a levee with a triangular section and a sharp crest.

The crest must, therefore, be given a considerable width and made horizontal or nearly so, in order that the original grade of the levee may be not materially reduced by the action of the elements, to enable the levee to resist the wave action, and to give room to work and place and handle material in case of needed repairs during high water. If, however, with a flat crown of considerable width the rear slope is made continuous to the base, the ratio of thickness to water pressure is no longer constant throughout the height, and the embankment has an excess of strength and

thickness towards its top, while such excess should be towards the bottom if it exists at all.

For low levees which have a large excess of strength at all points of their height, this is hardly a material consideration, and difficulties in construction render it unadvisable to attempt an approximation to the theoretical section. Levees of 10 feet in height, or less, are therefore given a regular slope on the land side, usually somewhat steeper than the river slope, and a width of crown varying with the height, but not exceeding 8 feet.

Levees of more than 10 feet in height have the broken slope above described, which is designed to give a section of more nearly uniform strength and power to resist sloughing, with greater economy of material than that heretofore used.

The width of crown for all heights is limited to 8 feet. This is sufficient to afford necessary facilities for protection work and to resist ordinary wave wash. For very low levees, where earth and other material can be placed on the crown from the ground surface, a less width is allowable. For high levees the strength of the embankment is neither uniformly nor economically increased by an increase of crown width alone.

In that part of the district below New Orleans the country is generally cleared and open, and the river is exposed to winds and storms. Large ocean steamships also frequently pass, and the levees are much exposed to the destructive action of waves. They are usually low embankments, rarely as much as 10 feet high. A section has been adopted for these levees having an 8-foot crown, a land slope of 2½ to 1, and a broken slope on the river side. This slope is made quite flat, 4 to 1, up to the foot of the revetment. Where the slope is entirely protected from waves it is made 2 to 1, or as steep as may be expected to stand under the ordinary action of the elements.

LEVEE REVETMENT.

The revetments so far constructed by this office have been built of a fair quality of cypress lumber. Posts and connecting rails are first placed to form a support and backing for the revetment. The planks are then driven close, edge to edge, along the front of the levee at the top of the lower slope. The planks are given an inclination towards the levee and are driven down to the natural ground. The tops are sawed even with the top of the levee, side pieces spiked on to secure the tops and braces fastened from the top of the completed revetment to stakes driven in the crown of the levee.

This form of revetment seems to be effective, but the exposed portion of the front slope having been reached by the rising water before the grass could cover it, has been in most cases partly washed away. It may be found necessary to make this slope much flatter than 4 to 1 or to omit it altogether.

TILE DRAINS FOR LEVEES.

The detrimental effect of seepage water or water which seeps or filters through the body of the levee in high water often becomes serious. The land slope and the ground in the rear is kept soft and wet, increasing the danger of sloughing; roads are rendered impassable, and in several cases large areas of cultivated land have been covered with seepage water, resulting in great loss. Since a levee falls short of serving its purpose, in so far as it fails to keep the water of the river off the lands adjacent, a remedy for the difficulty becomes a proper subject for investigation in connection with levee building. The trouble from this cause is most serious in the lower part of the district where the land is generally cultivated and the roads are numerous. Plantation ditches and facilities for drainage are also more frequent than above.

Heretofore open ditches have frequently been cut along the base of the levee, but they rapidly fill up and have to be frequently cleaned out. They are also ineffective on account of want of accuracy in grades, and with a slight fall that is usually available they have proved very unsatisfactory. It is therefore decided to try tile drains, and at a number of levees built during the past year a line of 6-inch tile drains were laid just at or near the base of the land slope and from 1 to 3 feet below the surface. The greatest care was required in excavating and grading the bottom of the ditch and placing and covering the tiles in order to secure good work and accuracy in grades. The tiles were usually carried across the road in the rear of levee and outlets placed connecting with the existing drains of the adjacent plantations or with available sloughs. Thus far the results have been highly satisfactory, and where these tiles have been placed the land slope and ground at the levee and the road have been kept dry and hard, while in many cases the new levee built without drains have shown the usual effects of seepage water.

Other new features which have been introduced into levee construction during the past year are as follows:

Greater care has been exercised in requiring the excavations in the borrow pits to be so made and connected by cuts that they may be effectually drained towards the river in low water, with a view to diminishing the crayfish evil. In several cases the wings of new levees or portions connecting the main line with existing embankment have been built with a reduced grade and section.

In the history of levee building onthe lower river it is found, that a new work, in the majority of cases, consists of a main line or "curtain" running parallel to the river and two "wings" connecting the main line with the existing levee above and below.

The curtain has, of course, the longest life, for in the course of time with continued recession of bank line, the wings are abandoned long before the main line ceases to be useful.

It is therefore allowable to economize on the wings and give to them a less factor of safety than to the curtain.

Locations in the lower portion of the river have not always been made with a view to leaving the old levee undisturbed to act as a breakwater for the new work as was previously the custom, but in many instances the old levee has been entirely removed and used to build the new levee, and the sacrifice of private property has been thus reduced.

In raising and enlarging existing levees it has heretofore been the practice to break up the surface of the old levee and then to bring it to the required height and section by adding earth without further disturbance of the old embankment. This practice has been modified by requiring the old levee to be cut down and spread out to the full width of base for the new work bringing the work to a level surface, and then completing it by adding fresh earth to the top. The object is to discover and remedy defects in the old embankment and to avoid unequal settling and cracking of the embankment.

The cutting of muck or base ditches within the base of the levee has been largely discontinued.

EXPERIMENTAL MACHINE FOR LEVEE BUILDING.

The Commission having authorized experiments with a view to developing mechanical appliances for levee work, as outlined in a report from this office of August 29, 1892, a high speed engine transferred by Capt. Roessler, in charge of the first and second districts, has been set up on the dredge boat *Pah-Ute*, connected with main boiler and placed in running order. The dredge will be used as a floating power station from which to operate the earth-handling apparatus. A portion of the material to construct the latter has been procured, but progress has been delayed by the great pressure of other work and by present flood. The experiments will be resumed as soon as the water subsides.

In conclusion, I think it can be said that there has been a material advance in the methods of levee construction during the past year, and that the results have been generally satisfactory.

Money statement.

LEVEES, TENSAS BASIN.

June 1, 1892, balance unexpended	$11,672.02
May 31, 1893, amount expended during fiscal year	11,672.02

PROTECTION OF LEVEES, TENSAS BASIN.

June 1, 1892, balance unexpended	8,103.17
May 31, 1893, amount expended during fiscal year	8,103.17

LEVEES, RIGHT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended	2,061.94
May 31, 1893, amount expended during fiscal year	2,061.94

PROTECTION OF LEVEES, RIGHT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended	$8,887.38
May 31, 1893, amount expended during fiscal year	8,887.38

LEVEES, LEFT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended	952.03
May 31, 1893, amount expended during fiscal year	952.03

PROTECTION OF LEVEES, LEFT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended	4,447.46
May 31, 1893, amount expended during fiscal year	4,447.46

LOWER TENSAS LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$150,000.00
May 31, 1893, amount expended during fiscal year:		
Construction and repairs of levees	$130,909.24	
Protection of levees	2,415.33	
		133,324.57
May 31, 1893, balance unexpended		16,675.43
May 31, 1893, amount covered by uncompleted contracts		15,319.99
July 1, 1893, balance available		1,355.44
Amount that can be profitably expended in fiscal year ending June 30, 1895		137,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

ATCHAFALAYA LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$155,000.00
May 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees	$126,809.59	
For protection of levees	707.12	
For levee machine	366.96	
		127,883.67
June 1, 1893, balance available		27,116.33
Amount that can be profitably expended in fiscal year ending June 30, 1895		152,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

LAFOURCHE LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$90,000.00
May 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees	$74,681.62	
For protection of levees	425.02	
		75,106.64
May 31, 1893, balance unexpended		14,893.36
May 31, 1893, amount covered by incomplete contracts		10,725.59
May 31, 1893, balance available		4,167.77
Amount that can be profitably expended in fiscal year ending June 30, 1895		90,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

PONTCHARTRAIN LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$150,000.00
May 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees	$131,226.73	
For protection of levees	944.70	
		132,171.43
May 31, 1893, balance unexpended		17,828.57
May 31, 1893, amount covered by uncompleted contracts		12,991.49
May 31, 1893, balance available		4,837.08
Amount that can be profitably expended in fiscal year ending June 30, 1895		150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

LAKE BORGNE LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$50,000.00
May 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees		49,704.81
May 31, 1893, balance unexpended		295.19
June 1, 1893, balance available		295.19
Amount that can be profitably expended in fiscal year ending June 30, 1895		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

BARATARIA LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$60,000.00
May 31, 1893, amount expended during fiscal year:		
For construction and repair of levees	$56,794.95	
For protection of levees	771.21	
		57,566.16
May 3, 1893, balance unexpended		2,433.84
June 1, 1893, balance available		2,433.84
Amount that can be profitably expended in fiscal year ending June 30, 1895		60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 15, 1892.

A.—*Abstract of proposals received in response to advertisement dated September 29, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River, viz:*

No.	Name and address of bidder.	Lafourche levee district.							
		Buena Vista—Minnie.				St. James Church.			
		Embankment, 76,690 cubic yards.	Base ditches, etc., 1,182 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.	Embankment, 112,000 cubic yards.	Base ditches, etc., 2,946 cubic yards.	Tile drains, 3,000 linear yards.	Total cost of levee.
		Cents.	*Cts.*	*Cts.*		*Cents.*	*Cts.*	*Cts.*	
1	Thos. O'Malley, Baton Rouge, La	32	35	50	$25,704.50	35	.....	.....	$39,200.00
3	W. J. Bentley & Co., Green's Store, La	.....	.....	.....	.....	21½	15	50	25,741.90
4	Homan, McFadden & Cassidy, Baton Rouge, La					19.7	20	27	23,463.20
6	J. A. McTighe & Co., Memphis, Tenn	29	25	90	23,885.60	28	25	90	34,796.50
7	Scott & Russell, Memphis, Tenn	23	17	35	18,364.64	21	17	35	25,070.82
8	W. O. Flynn & Co., Baton Rouge, La	22½	17	40	18,247.91	*17	*17	*40	20,740.82
10	James N. Ogden, Baton Rouge, La	22	20	30	17,558.20	23.95	18	30	28,254.28
11	Jeffries & Dameron, Stovall, Miss	25	20	30	19,858.90	20	20	30	23,889.20
12	Jno. Scott & Son, St. Louis, Mo	23½	12	25	18,528.99	22.49	12	25	26,292.32
13	Andrews Bros. Construction Co., Baton Rouge, La	19½	30	90	16,467.52	.....	30	90	.....
14	J. M. Sullivan, Memphis, Tenn	*19½	*19½	*50	15,935.04	21½	21½	50	26,213.39

No.	Name and address of bidder.	Lafourche levee district.				Pontchartrain levee district.			
		St. James estate.				Dicharry, lower.			
		Embankment, 16,500 cubic yards.	Base ditches, etc., 372 cubic yards.	Tile drains, 466 linear yards.	Total cost of levee.	Embankment, 78,000 cubic yards.	Base ditches, etc., 1,100 cubic yards.	Tile drains, 1,700 linear yards.	Total cost of levee.
		Cents.	*Cts.*	*Cts.*		*Cents*	*Cts.*	*Cts.*	
1	Thos. O'Malley, Baton Rouge, La	.....	.....	.....	.....	30	.....	.....	$23,400.00
3	W. J. Bentley & Co., Green's Store, La	.....	.....	.....	.....	27	20	50	22,130.00
4	Homan, McFadden & Cassidy, Baton Rouge, La	.....	.....	.....	.....	21	21	27	17,070.00
5	P. J. Coffman, Burnside P. O., La	.....	.....	.....	.....	20	18	30	16,308.00
6	J. A. McTighe & Co., Memphis, Tenn	25	25	90	$4,637.40	29	25	90	24,425.00
7	Scott & Russell, Memphis, Tenn	21	17	35	3,691.34	23	17	35	18,722.00
8	W. O. Flynn & Co., Baton Rouge, La	.....	.....	.....	.....	23	17	40	18,807.00
9	P. Harnan, New Orleans, La	*24.9	26	37	.....	.....	.....	.....	.....
11	Jeffries & Dameron, Stovall, Miss	20	20	30	3,514.20	22	20	30	17,890.00
13	Jno. Scott & Son, St. Louis, Mo	21½	12	25	3,708.64	26	12	25	20,837.00
14	J. M. Sullivan, Memphis, Tenn	*18½	*18½	*50	3,354.32	*19	*19	*50	15,879.00

	Lafourche levee district.	Pontchartrain levee district.
Amount available	$84,000.00	$144,000.00
Amount covered by this abstract	40,030.18	28,332.50
Balance	43,969.82	115,667,50

REMARKS.—All proposals marked thus (*) being lowest and bidders responsible, are recommended for acceptance, except tile drains for Tippecanoe levee, which are recommended for rejection.

B.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Lafourche levee district. Jamestown. Embankment, 20,500 cubic yards.	Base ditches, etc., 468 cubic yards.	Tile drains, 466 linear yards.	Total cost of levee.	Pontchartrain levee district. Tessier. Embankment, 82,000 cubic yards.	Base, ditches, etc., 1,372 cubic yards.	Tile drains, 1,433 linear yards.	Total cost of levee.	Hope. Embankment, 61,500 cubic yards.	Base ditches, etc., 1,311 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.
1	Jeffries & Dameron, Stovall, Miss	Cts.	Cts.	Cts.		Cts. *21½	Cts. *18	Cts. *30	$15,511.86	Cts. *20	18	30	$12,985.98
3	W. O. Flynn & Co., Baton Rouge, La					24½	18	40	21,217.66	18½	18	40	12,136.60
6	Sullivan & Johnson, Memphis, Tenn	21	21	50	$4,636.28	25	25	50	21,559.50	21½	21½	50	14,254.36
7	Thos. O'Malley, Baton Rouge, La	25	25	50	5,475.00	25	25	50	21,559.50	25	25	50	16,452.75
8	P. Harnan, New Orleans, La	23	23	35	4,985.74								
9	Jas. N. Ogden, Baton Rouge, La	*19.70	*19.70	*40	4,317.10					22	20	40	14,392.20
10	P. J. Coffman, Burnside, La	20¾	19	35	4,505.77	28	20	30	23,664.30	*18.45	*18	*35	12,107.73
11	Noble W. Irish, Carlyle, Ill	21½	19	50	4,729.42								
13	John Scott & Son, St. Louis, Mo	22	16	30	4,724.68	23½	16	30	19,919.42	23½	16	30	15,112.26
16	Homan, McFadden & Cassidy, Baton Rouge, La					23.7	20	28	20,109.60	18.7	18.7	35	12,270.66
17	J. S. McTighe & Co., Memphis, Tenn	30	25	45	6,476.70	35	25	45	29,687.85	30	25	45	19,452.75

	Atchafalya levee district.	Lafourche levee district.	Pontchartrain levee district.
Amount available	$140,000.00	$43,069.82	$115,078.69
Amount covered by this abstract	81,890.45	4,317.10	30,619.59
Balance	58,109.55	39,652.72	84,459.10

REMARKS.—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 17, 1892.

B.—*Abstract of proposals received in response to advertisement dated September 29, 1892, opened this day by Capt. John Millis, Corps of Engineers, for construction of levees in fourth district, Mississippi River.*

No.	Name and address of bidder.	Atchafalaya levee district.							
		Barroza, upper.				Barroza, middle.			
		Embankment, 100,000 cubic yards.	Base ditches, etc., 900 cubic yards.	Tile drains, 900 linear yards.	Total cost of levee.	Embankment, 100,000 cubic yards.	Base ditches, etc., 800 cubic yards.	Tile drain, 800 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss	32	25	30	$32,495.00	36	28	30	$36,464.00
6	Sullivan & Johnson, Memphis, Tenn	30⅛	50⅛	50	31,224.50	33⅛	33⅛	50	34,168.00
13	John Scott & Son, St. Louis, Mo	28	16	30	28,414.00	*30⅛	*16	*30	30,868.00
14	James A. Andrews, Baton Rouge, La	*27½	*27½	*55	28,242.50	31	31	55	31,688.00
15	Timothy W. Scott, Memphis, Tenn	42	25	40	42,585.00				
17	J. S. McTighe & Co., Memphis, Tenn	42	25	40	42,585.00	45	25	45	45,560.00

No.	Name and address of bidder.	Atchafalaya levee district.						
		Belair.			Medora.			
		Embankment, 40,500 cubic yards.	Base, ditches, etc., 90 cubic yards.	Total cost of levee.	Embankment, 70,000 cubic yards.	Base, ditches, etc., 946 cubic yards.	Tile drains, 1,166 linear yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss	23	20	$9,333.00	24	20	30	$17,339.00
2	Sterling Fort, Greenville, Miss				20	20	50	14,772.20
4	I. R. Bobbitt, Baton Rouge, La	22	16	8,924.40				
5	Iverson G. Batchelor, Smithland, La	24.95	24.95	10,127.20				
6	Sullivan & Johnson, Memphis, Tenn	21⅛	21⅛	8,726.85	22⅛	22⅛	50	16,545.85
9	Jas. N. Ogden, Baton Rouge, La	33	33	13,394.70				
11	Noble W. Irish, Carlyle, Ill				22⅛	19	50	16,512.74
12	Ovide Lacour, Raccourci, La	21	15	8,518.50	24	20	25	17,280.70
13	John Scott & Son, St. Louis, Mo	24	16	9,734.40	24	16	30	17,301.16
14	James A. Andrews, Baton Rouge, La	24	24	9,741.60	21	21	55	15,539.96
15	Timothy W. Scott, Memphis, Tenn	*19¼	*10	8,007.75	24	10	35	17,302.70
16	Homan, McFadden & Cassidy, Baton Rouge, La	21⅛	18	8,723.70				
17	J. S. McTighe & Co., Memphis, Tenn	35	25	14,197.50	37	25	45	26,661.20

B.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Lafourche levee district. Jamestown. Embankment, 20,500 cubic yards.	Base ditches, etc., 468 cubic yards.	Tile drains, 466 linear yards.	Total cost of levee.	Pontchartrain levee district. Tessier. Embankment, 82,000 cubic yards.	Base, ditches, etc., 1,372 cubic yards.	Tile drains, 1,433 linear yards.	Total cost of levee.	Hope. Embankment, 61,500 cubic yards.	Base ditches, etc., 1,311 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.
1	Jeffries & Dameron, Stovall, Miss	*Cts.*	*Cts.*	*Cts.*		*Cts.* 21¼	*Cts.* *18	*Cts.* *30	$15,511.86	*20	18	30	$12,985.98
3	W. O. Flynn & Co., Baton Rouge, La					24⅞	18	40	21,217.66	18⅜	18	40	12,136.60
6	Sullivan & Johnson, Memphis, Tenn	21	21	50	$4,636.28	25	25	50	21,559.50	21½	21½	50	14,254.36
7	Thos. O'Malley, Baton Rouge, La	25	25	50	5,475.00	25	25	50	21,559.50	25	25	50	16,452.75
8	P. Harnan, New Orleans, La	23	23	35	4,985.74								
9	Jas. N. Ogden, Baton Rouge, La	*19.70	*19.70	*40	4,317.10					22	20	40	14,392.20
10	P. J. Coffman, Burnside, La	20¾	19	35	4,505.77	28	20	30	23,664.30	*18.45	*18	*35	12,107.73
11	Noble W. Irish, Carlyle, Ill	21½	19	50	4,729.42								
13	John Scott & Son, St. Louis, Mo	22	16	30	4,724.68	23½	16	30	19,919.42	23½	16	30	15,112.26
16	Homan, McFadden & Cassidy, Baton Rouge, La					23.7	20	28	20,109.60	18.7	18.7	35	12,270.66
17	J. S. McTighe & Co., Memphis, Tenn	30	25	45	6,476.70	35	25	45	29,687.85	30	25	45	19,452.75

	Atchafalya levee district.	Lafourche levee district.	Pontchartrain levee district.
Amount available	$140,000.00	$43,969.82	$115,078.69
Amount covered by this abstract	81,890.45	4,317.10	30,619.59
Balance	58,109.55	39,652.72	84,459.10

REMARKS.—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 18, 1892.

C.—*Abstract of proposals received in response to advertisement dated September 29, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Atchafaylaya levee district.							
		Hickey, upper.				Hickey, lower.			
		Embankment, 125,000 cubic yards.	Base ditches, etc., 1,100 cubic yards.	Tile drains, 900 linear yards.	Total cost of levee.	Embankment, 125,000 cubic yards.	Base ditches, etc., 1,400 cubic yards.	Tile drains, 1,100 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss.	28	18	30	$35,468.00	23	18	30	$29,332.00
4	J. S. McTighe & Co., Memphis, Tenn.	45	25	55	57,020.00	38	25	55	48,455.00
5	Scott & Russel, Memphis, Tenn.					35	16	35	44,359.00
6	John Scott & Son, St. Louis, Mo.	30	16	30	37,946.00	24½	16	30	31,179.00
11	Sullivan & Johnson, Memphis, Tenn.	31½	25	45	40,055.00	27½	25	45	35,532.50
16	W. J. Bentley & Co., Green Store, La.	*27	*25	*45	34,430.00	24	25	45	30,845.00

No.	Name and address of bidder.	Atchafayla levee district.				Lafourche levee district.			
		Fortville, lower.				Home Place.			
		Embankment, 35,000 cubic yards.	Base ditches, etc., 573 cubic yards.	Tile drains, 700 linear yards.	Total cost of levee.	Embankment, 63,500 cubic yards.	Base ditches, etc., 937 cubic yards.	Tile drains, 1,167 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss.					22	18	30	$14,488.76
2	James N. Ogden, Baton Rouge, La.					19.70	19.70	35	13,102.54
4	J. S. McTighe & Co., Memphis, Tenn.	28	25	55	$10,328.25	28	25	55	18,656.10
5	Scott & Russel, Memphis, Tenn.	20½	15	35	7,505.95				
6	John Scott & Son, St. Louis, Mo.	25	16	30	9,051.68	22	16	30	14,470.02
8	I. R. Bobbitt, Baton Rouge, La.	21	16	40	7,721.68				
9	Ovide Lacour, Raccource, La.	*20½	†20½	*29	7,495.46				
10	P. J. Coffman, Burnside, La.					20½	17	35	13,743.99
11	Sullivan & Johnson, Memphis, Tenn.	25	25	45	9,208.25	22½	15	45	14,953.20
12	Andrews Bros. Construction Co., Baton Rouge, La.	21	21	50	7,820.33	20½	20½	55	13,851.43
14	Homan, McFadden & Cassidy, Baton Rouge, La.					*19½	*18	*30	12,901.26

C.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.											
		Burtville.				Oakley to St. Gabriel.				Burnside.			
		Embankment, 98,000 cubic yards.	Base ditches, etc., 1,484 cubic yards.	Tile drains, 1,667 linear yards.	Total cost of levee.	Embankment, 68,000 cubic yards.	Base ditches, etc., 1,260 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.	Embankment, 41,000 cubic yards.	Base ditches, etc., 1,964 cubic yards.	Tile drains, 1,166 linear yards.	Total cost of levee.
1	Jeffries & Dameron, Stovall, Miss	*Cts.* 23	*Cts.* 18	*Cts.* 30	$23,307.22	*Cts.* 25	*Cts.* 18	*Cts.* 30	$17,676.80	*Cts.* 22	*Cts.* 18	*Cts.* 30	$9,723.32
2	James N. Ogden, Baton Rouge, La	21.45	21.45	35	21,922.77	22	22	35	15,762.20	18.90	18.70	35	8,442.37
3	P. Harnan, New Orleans, La	.....	.....	.....	.....	27	25	39	19,260.00	23.9	24	36	10,690.12
4	J. S. McTighe & Co., Memphis, Tenn	33	25	55	33,627.85	26	26	55	18,832.60	24	24	55	10,952.66
5	Scott & Russel, Memphis, Tenn	.....	.....	.....	.....	20½	15	35	14,484.00	21	15	35	9,312.70
6	John Scott & Son, St. Louis, Mo	28	16	30	28,177.54	26	16	30	18,331.60	21	16	30	9,274.04
7	Noble W. Irish, Carlyle, Ill	.....	.....	.....	.....	21⅞	18	46	15,791.80	20⅞	18	46	9,448.63
8	I. R. Bobbitt, Baton Rouge, La	.....	.....	.....	.....	19	16	40	13,721.60	*17.99	*12	*30	7,961.38
10	P. J. Coffman, Burnside, La	24	18	35	24,370.57	21	17	35	15,019.20	18	16	35	8,102.34
11	Sullivan & Johnson, Memphis, Tenn	25	25	45	25,621.15	21½	21½	45	15,565.90	21	15	45	9,429.30
12	Andrews Bros. Construction Co., Baton Rouge, La	22	22	55	22,803.33	19½	16	50	14,041.60	19	16	50	8,687.24
13	W. O. Flynn & Co., Baton Rouge, La	25⅜	18	40	25,801.42	20	18	40	14,426.80	18	18	40	8,199.92
14	Homan, McFadden & Cassidy, Baton Rouge, La	*21	*16	*27	21,267.53	*19	*15	*27	13,514.60	18	16	27	8,009.06
15	Mike Kane, Baton Rouge, La	.....	.....	.....	.....	.....	.....	.....	.....	19	19	38	8,606.24

REMARKS.—Proposals marked thus (*) being lowest and bidders responsible, are recommended for acceptance. No bid for Hickey lower levee is recommended for acceptance under amount now available owing to lack of funds.

	Atchafalaya levee district.	Lafourche levee district.	Pontchartrain levee district.
Amount available, Abstract B	$58,109.55	$39,652.72	$84,459.10
Amount covered by this abstract	41,925.46	12,901.26	42,742.91
Balance	16,184.09	26,751.46	41,716.19

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 15, 1892.

D.—***Abstract of proposals received in response to advertisement dated October 1, 1892, and opened this day by Capt. John Millis, Corps of Engineers, for constructing levees in fourth district, Mississippi River.***

No.	Name and address of bidder.	Lower Tensas Levee district.									
		Hardscrabble, lower.			Bondurant.		Morville.		Fish Pond.		
		Embankment, 90,000 cubic yards.	Base ditches, etc., 1,790 cubic yards.	Total cost of levee.	Embankment, 23,973 cubic yards.	Total cost of levee.	Embankment, 30,000 cubic yards.	Total cost of levee.	Embankment, 110,000 cubic yards.	Base ditches, etc., 3,455 cubic yards.	Total cost of levee.
1	Hanlon & Dowdell, Legonier, La	*Cts.*	*Cts.*		*Cents.*		*Cents.* 18	$5,400.00	*Cts.* 21	*Cts.* 18	$23,721.90
2	Augustus P. Martin, Waterproof, La	39	35	$35,726.50	21	$5,034.33	22	6,600.00	22	22	24,960.10
3	J. S. McTighe & Co., Memphis, Tenn	*25	*25	22,947.50	22	5,274.06	22	6,600.00	23	25	26,163.75
4	J. M. Sullivan, Memphis, Tenn								18	18	20,421.90
5	John J. Quinn and Nat P. Philips, Red River Landing, La., and Merricks, La				16	3,835.68	15¾	4,725.00	18.7	16	21,122.80
6	Rutherford & Dalgarn, Natchez, Miss	45	45	41,305.50	21.5	5,154.19	17¾	5,325.00	21½	21½	24,392.82
7	W. O. Flynn & Co., Baton Rouge, La						17	5,100.00	15⅞	15⅞	18,010.98
8	Ernest Hyner, Greenville, Miss	28	19	25,540.10					18	18	20,421.90
9	Manning & Gibson, Natchez, Miss				*15.94	3,821.30	*14.94	4,482.00	20	20	22,691.00
10	Ignatz Friedler, Vidalia, La						15	4,500.00			
11	James S. Fleming and Samuel H. Landin, jr., Natchez, Miss						18	5,400.00			
12	William Curry, St. Joseph, La				17	4,075.41					

	Lower Tensas Levee district.
Amount available	$116,000.00
Amount covered by this abstract	48,656.28
Balance	67,343.72

REMARKS.—Proposals marked thus (*) being the lowest, and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 17, 1892.

E.—Abstract of proposals received in response to advertisement dated October 2, 1892, and opened this day by Capt. John Millis, Corps of Engineers, for construction of levees in fourth district, Mississippi River.

No.	Name and address of bidder.	Barataria Levee district.											
		Fort St. Leon, upper.				Fort St. Leon, middle.				Belle Chasse crevasse.			
		Embankment, 11,900 cubic yards.	Base ditches, etc., 2,386 cubic yards.	Tile drains, 617 linear yards.	Total cost of levee.	Embankment, 18,700 cubic yards.	Base ditches, etc., 4,697 cubic yards.	Tiledrains, 1,266 linear yards.	Total cost of levee.	Embankment, 4,320 cubic yards.	Base ditches, etc., 863 cubic yards.	Tile drains, 223 linear yards.	Total cost of levee.
1	J. S. McTighe & Co., Memphis, Tenn	*Cts.* 25	*Cts.* 25	*Cts.* 45	$3,849.15	*Cts.* 27	*Cts.* 25	*Cts.* 45	$6,842.95	*Cts.* 35	*Cts.* 35	*Cts.* 45	$1,914.40
2	Robert McNamara, New Orleans, La	23	23	40	3,532.58	27	25	40	6,779.65	39	25	40	1,989.75

No.	Name and address of bidder.	Barataria Levee district.							
		Concord.				Oakville.			
		Embankment, 27,000 cubic yards.	Base ditches, etc., 3,326 cubic yard.	Tile drains 860 linear yards.	Total cost of levee.	Embankment, 28,160 cubic yards.	Base ditches, etc., 6,000 cubic yards.	Tile drains, 1,546 linear yards.	Total cost of levee.
1	J. S. McTighe & Co., Memphis, Tenn	*Cts.* 32	*Cts.* 32	*Cts.* 45	$10,091.32	*Cts.* 28	*Cts.* 28	*Cts.* 45	$10,260.50
2	Robert McNamara, New Orleans, La	24½	24½	40	7,773.87	30	30	40	10,866.40

REMARKS.—By telegram of October 18, 1892, to the Chief of Engineers U. S. A., recommended rejection of all bids, being too high.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 18, 1892.

F.—*Abstract of proposals received in response to advertisement dated October 2, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Barataria Levee district.											
		Magnolia, enlargement.				Fort St. Leon, lower.				Belle Chasse to concession, new and enlargement.			
		Embankment, 2,200 cubic yards.	Base ditches, etc., 10,700 cubic yards.	Tile drains, 2,767 linear yards.	Total cost of levee.	Embankment, 7,200 cubic yards.	Base ditches, etc., 1,187 cubic yards.	Tile drains, 307 linear feet.	Total cost of levee.	Embankment, 39,050 cubic yards.	Base ditches, etc., 16,500 cubic yards.	Tile drains, 4,266 linear yards.	Total cost of levee.
1	Robert McNamara, New Orleans, La	*Cts.* *25	*Cts.* *20	*Cts.* *40	$9,296.80	*Cts.* 23	*Cts.* 20	*Cts.* 40	$2,016.20	*Cts.* 23	*Cts.* 20	*Cts.* 40	$13,987.90
2	J. S. McTighe & Co., Memphis, Tenn	28	28	55	11,293.85	32	32	55	2,852.69	33⅓	33⅓	55	20,862.97
3	Jas. N. Ogden, Baton Rouge, La	25	25	40	9,831.80	*22	*22	*40	1,967.94	*22	*22	*40	13,927.40

No.	Name and address of bidder.	Barataria Levee district.							
		Oak Point.				Live Oak, new and enlargement.			
		Embankment, 12,310 cubic yards.	Base ditches, etc., 2,743 cubic yards.	Tile drains, 712 linear yards.	Total cost of levee.	Embankment, 9,880 cubic yards.	Base ditches, etc., 1,868 cubic yards.	Tile drains, 483 linear yards.	Total cost of levee.
1	Robert McNamara, New Orleans, La	*Cts.* 23	*Cts.* 20	*Cts.* 40	$3,664.70	*Cts.*	*Cts.*	*Cts.*	.....
2	J. S. McTighe & Co., Memphis, Tenn	28	28	55	4,606.44	32	32	55	$4,025.01
3	Jas. N. Ogden, Baton Rouge, La	*22	*22	*40	3,596.46	*22	*22	*40	2,777.76

	Barataria Levee district.
Amount available	$57,000.00
Amount covered by this abstract	31,566.36
Balance	25,433.64

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 19, 1892.

G.—*Abstract of proposals received in response to advertisement dated October 4, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	La Fourche Levee district.											
		Providence.				Lone Star.				Davis.			
		Embankment, 34,500 cubic yards.	Base ditches, etc., 629 cubic yards.	Tile drains, 733 linear yards.	Total cost of levee.	Embankment, 63,500 cubic yards.	Base ditches, etc., 1,358 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.	Embankment, 43,000 cubic yards.	Base ditches, etc., 605 cubic yards.	Tile drains, 667 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	John E. Louque, Carrollton, La					20	20	50	$13,721.60	21	21	50	$9,490.55
2	P. J. Coffman, Burnside, La					20	14	30	13,340.12	24	18	35	10,602.35
3	Jno. Scott & Son, St Louis, Mo	24	16	30	$8,600.54	22	16	30	14,637.28	24	16	30	10,616.90
4	J. S. McTighe & Co., Memphis, Tenn	30	30	55	10,941.85	31	30	55	20,917.40	35	35	55	15,628.60
5	J. N. Ogden, Baton Rouge, La	18.7	18.7	30	6,789.02	21.95	18	30	14,632.60				
6	James A. Brennan, New Orleans, La												
7	John Cleary, Carrollton, La												

No.	Name and address of bidder.	La Fourche Levee district.				Pontchartrain Levee district.			
		Fairfield.				Trudeau.			
		Embankment, 32,500 cubic yards.	Base ditches, etc., 445 cubic yards.	Tile drains, 533 linear yards.	Total cost of levee.	Embankment, 63,000 cubic yards.	Base ditches, etc., 986 cubic yards.	Tile drains, 1,200 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	John E. Louque, Carrollton, La					*23	*14	*30	$14,988.04
2	P. J. Coffman, Burnside, La								13,267.76
3	Jno. Scott & Son, St. Louis, Mo	26	16	30	$8,681.10	25	16	30	
4	J. S. McTighe & Co., Memphis, Tenn	35	35	55	11,823.90	32	32	55	21,135.52
5	J. N. Ogden, Baton Rouge, La								
6	James A. Brennan, New Orleans, La	21.91	20	50	8,451.25				
7	John Cleary, Carrollton, La					28	20	35	18,257.20

	La Fourche Levee district.	Pontchartrain Levee district.
Amount available, Abstract C	$26,751.46	$41,716.19
Amount covered by this abstract	22,830.67	14,988.04
Balance	3,920.79	26,728.15

REMARKS.—Proposals marked thus * (Lone Star, Davis, and Trudeau levees) are recommended for acceptance, being the lowest and the bidders responsible. All proposals for Providence and Fairfield levees are recommended for rejection, owing to insufficiency of funds.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 19, 1892.

H.—*Abstract of proposals received in response to advertisement dated October 5, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne Levee district.											
		Slaughter House.				Roy.				Bonzano.			
		Embankment, 1,360 cubic yards.	Base ditches, etc., 446 cubic yards.	Tile drains, 238 linear yards.	Total cost of levee.	Embankment, 8,356 cubic yards.	Base ditches, etc., 708 cubic yards.	Tile drains, 379 linear yards.	Total cost of levee.	Embankment, 4,624 cubic yards.	Base ditches, etc., 473 cubic yards.	Tile drains, 227 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James Byrne, Baton Rouge, La												
2	Louis Louque, New Orleans, La	*19.99	*17	*50	$466.68	*19.99	*17	*50	$1,980.22	*19.99	*17	*50	$1,109.75
3	Robert McNamara, New Orleans, La	30	20	40	592.40	44	20	40	3,969.84	44	20	40	2,209.96

No.	Name and address of bidder.	Lake Borgne Levee district.							
		Chalmette Cemetery.				Deboushel.			
		Embankment, 5,128 cubic yards.	Base ditches, etc., 548 cubic yards.	Tile drains, 294 linear yards.	Total cost of levee.	Embankment, 6,760 cubic yards.	Base ditches, etc., 434 cubic yards.	Tile drains, 232 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James Byrne, Baton Rouge, La					22.50	22.50	40	$1,718.20
2	Louis Louque, New Orleans, La	*19.99	*17	*50	$1,276.04	*18.99	*17	*50	1,479.20
3	Robert McNamara, New Orleans, La	34	20	40	1,970.72	26	20	40	1,945.00

	Lake Borgne Levee district.
Amount available	$47,000.00
Amount covered by this abstract	6,311.89
Balance	40,688.11

REMARKS.—Proposals marked thus (*) being the lowest received and considered reasonable, and the bidder responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 21, 1892.

—*Abstract of proposals received in response to advertisement dated October 8, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district.							
		Pecan Grove, new and enlargement.				Story, upper, enlargement.*			
		Embankment, 12,620 cubic yards.	Base ditches, etc., 91,- cubic yards.	Tile drains, 488 linear yards.	Total cost of levee.	Embankment, 5,000 cubic yards.	Base ditches, etc., 1,000 cubic yards.	Tile drains, 433 linear yards.	Total cost of levee.
1	James Byrne, Baton Rouge, La...	Cts. 22½	Cts. 22½	Cts. 42	$3,249.66	Cts.	Cts.	Cts.	

No.	Name and address of bidder.	Lake Borgne levee district.							
		Story, lower, new and enlargement.*				Repose.*			
		Embankment, 32,520 cubic yards.	Base ditches, etc., 8,390 cubic yards.	Tile drains, 1,548 linear yards.	Total cost of levee.	Embankment, 13,200 cubic yards.	Base ditches, etc., 904 cubic yards.	Tile drains, 485 linear yards.	Total cost of levee.
1	James Byrne, Baton Rouge, La...	Cts.	Cts.	Cts.		Cts.	Cts.	Cts.	

	Lake Borgne levee district
Amount available, Abstract H	$40,688.11
Amount covered by this abstract	3,249.66
Balance	37,438.45

* No bid.

REMARKS.—Proposal for Pecan Grove levee is the only bid received. It is considered reasonable and the bidder responsible, and is recommended for acceptance. Authority to readvertise Story, upper, Story lower, and Repose levees has been received from the Department by telegram dated October 22, 1892.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 24, 1892.

J.—*Abstract of proposals received in response to advertisement dated October 12, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district—Grasamere to Wiocema.			
		Embankment, 83,000 cubic yards.	Base ditches, etc., 7,400 cubic yards.	Tile drains, 9,000 linear yards.	Total cost of levee.
		Cents.	*Cents.*	*Cents.*	
1	McLaughlin Brothers, Memphis, Tenn	*17½	*16	*35	$18,859.00
2	Ernest Hyner, Greenville, Miss	18¾	18½	40	20,324.00
3	Jeffries & Dameron, Stovall, Miss	18¾	18½	35	20,100.00
4	Noble W. Irish, Carlyle, Ill	18⅞	18	45	20,903.00
5	John Scott & Son, St. Louis, Mo	20	16	30	20,484.00
6	Manning & Gibson, Natchez, Miss	21½	21½	38	22,856.00
7	Haulon & Dowdell, Legonier, La	17	15	42	19,000.00
8	Augustus P. Martin, Waterproof, La	16¾	16¾	.....	15,142.00
9	Rutherford & Dalgarn, Natchez, Miss	19½	19½	38	21,048.00
10	C. F. De Garis & Co., Memphis, Tenn	18½	17½	38	19,768.00

	Lower Tensas levee district.
Amount available, Abstract D	$67,343.72
Amount covered by this abstract	18,859.00
Balance	48,484.72

REMARKS.—No. 8, Augustus P. Martin, does not bid on tile drains. Proposal marked thus (*) being the lowest received, and considered reasonable and bidder responsible, is recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 25, 1892.

L.—*Abstract of proposals received in response to advertisement dated October 14, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district. Wiccema to Fletcher. Embankment, 117,410 cubic yards.	Base, ditches, etc., 7,700 cubic yards.	Tile drains, 9,000 linear yards.	Total cost of levee.	Lake Borgne levee district. Caernarvon. Embankment, 30,000 cubic yards.	Base ditches, etc., 700 cubic yards.	Tile drains, 700 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Ernest Hyner, Greenville, Miss	17¼	17½	40	$25,181.47				
2	Manning & Gibson, Natchez, Miss	*16.49	*16.49	35	23,780.64				
3	Noble W. Irish, Carlyle, Ill	17.4	17.4	40	25,369.14				
4	P. M. Harnan, New Orleans, La					30	25	59	$9,588.00
6	W. O. Flynn & Co., Baton Rouge, La	23	17	40	31,913.30				
7	James Cotten, Raccourci, La	18.45	18	42	26,828.14				
8	Augustus P. Martin, Waterproof, La	17	17		21,268.70				
9	C. F. De Garis & Co., Memphis, Tenn	17⅞	17⅛	38	25,754.54				
10	Rutherford & Dalgarn, Smithland, La	18.9	18.9	35	26,795.79				
11	Sullivan, Johnson & McLaughlin, Memphis, Tenn	17.74	17.74		24,894.51				
12	Hanlon & Dowdell, Legonier, La	17.49	16½	20	24,180.82				
13	John Scott & Son, St. Louis, Mo	18	16	30	25,065.80				
14	Iverson G. Batchelor, Smithland, La	18	18	40	26,119.80				

No	Name and address of bidder.	Lake Borgne levee district. Orange Grove, upper. Embankment, 70,000 cubic yards.	Base ditches, etc., 1,100 cubic yards.	Tile drains, 1,567 linear yards.	Total cost of levee.	Orange Grove, lower. Embankment, 23,700 cubic yards.	Base ditches, etc., 900 cubic yards.	Tile drains, 900 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
4	P. M. Harnan, New Orleans, La					28½	25	59	$7,510.50
5	P. J. Reilly, New Orleans, La	*23	*20	*44	$17,009.48	*23½	*20	*44	6,145.50

	Lower Tensas levee district.	Lake Borgne levee district.
Amount available, Abstracts J and I	†$48,484.72	‡$37,438.45
Amount covered by this abstract	23,780.64	23,154.98
Balance	24,704.08	14,283.47

† Abstract J. ‡ Abstract I.

REMARKS.—All proposals marked thus * (Wiccema to Fletcher, Orange Grove, upper and lower levees) being lowest, and bidders responsible, are recommended for acceptance. Proposal No. 4, of P. M. Harnan, for Caernarvon levee, recommended for rejection; bid too high. No. 8, Augustus P. Martin, did not bid on tile drains.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 2, 1892.

L.—*Abstract of proposals received in response to advertisement dated October 19, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district.							
		Fletcher to Minorca, new and enlargement.				Minorca to Minors, new and enlargement.			
		Embankment, 80,000 cubic yards.	Tile ditches, etc., 5,800 cubic yards.	Tiledrains, 6,600 linear yards.	Total cost of levee.	Embankment, 84,000 cubic yards.	Tile ditches, etc., 6,200 cubic yards.	Tiledrains, 7,300 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	John Scott & Son, St. Louis, Mo	18	16	30	$17,308.00	18	16	30	$18,302.00
2	A. P. Martin, Waterproof, La	16⅔	16⅔	30	16,351 50				
3	James Cotten, New Orleans, La	18	12½	32	17,237.00	17.49	12½	32	17,802.60
4	G. W. Reagan, Red River Landing, La	17.44	20	40	17,752.00				
5	Manning & Gibson, Natchez, Miss	15.50	15	25	14,920.00	17.75	17.75	35	18,565.50
6	Quinn & Phillips, Merrick, La	16⅔	16	30	16,108.00	19	16½	30	19,173.00
7	Haulon & Dowdell, Legonier, La	17	9	20	15,442.00				
8	Iverson G. Batchelor, Smithland, La	16¼	16	25	15,578.00				
9	C. F. De Garis & Co., Memphis, Tenn	16⅔	16	36	16,804.00	16⅔	16	35	17,512.00
10	Albert Henry Gillespie, Vidalia, La					*14	*13.50	*29	14,714.00
11	McLaughlin Bros., Memphis, Tenn	16	16	35	16,038.00	16.90	16.99	35	17,879.98
12	J. L. Kingsbury, Red River Landing, La					17	26½	16	17,091.00
14	Noble W. Irish, Carlyle, Ill	16⅔	15	35	16,280.00	15⅔	15	34	16,747.00
15	Rutherford & Dalgarn, Natchez, Miss	*15 4/10	*15 4/10	*20	14,533.20	16 4/10	16 4/10	25	16,617.80
16	Kilpatrick & Storer, Collins, La	15	13	35	15,064.00	16	13	35	16,801.00

No.	Name and address of bidder.	Pontchartrain levee district.		Barataria levee district.			
		Whitehall.		Happy Point, new and enlargement.			
		Embankment, 3,500 cubic yards.	Total cost of levee.	Embankment, 8,030 cubic yards.	Base ditches, etc., 940 cubic yards.	Tile drains, 503 linear yards.	Total cost of levee.
		Cts.		*Cts.*	*Cts.*	*Cts.*	
1	John Scott & Son, St. Louis, Mo	22	$770.00				
11	McLaughlin Bros., Memphis, Tenn	*21½	752.50				
13	James N. Ogden, Baton Rouge, La			*23	*23	*30	$2,214.00

	Lower Tensas levee district.	Pontchartrain levee district.	Barataria levee district.
Amount available, Abstracts K, G, and M	†$24,704.08	‡$26,728.15	§$15,685.04
Amount reserved for other needed repairs to levees not now foreseen	20,000.00		
Total available	44,704.08	26,728.15	15,685.04
Amount covered by this abstract	29,247.20	752.50	2,214.00
Balance	15,456.88	25,975.65	13,471.04

REMARKS.—All proposals marked thus (*), being the lowest and the bidder responsible, are recommended for acceptance.

† Abstract K. ‡ Abstract G. § Abstract M.

M.—*Abstract of proposals received in response to advertisement dated October 20, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Barataria levee district.											
		Fort St. Leon, upper.				Fort St. Leon, middle enlargement.				Belle Chasse crevasse, new and enlargement.			
		Embankment, 11,900 cubic yards.	Base, ditches, etc., 2,380 cubic yards.	Tile drains, 617 linear yards.	Total cost of levee.	Embankment, 18,700 cubic yards.	Base, ditches, etc., 4,897 cubic yards.	Tile drains, 1,236 linear yards.	Total cost of levee.	Embankment, 4,350 cubic yards.	Base, ditches, etc., 863 cubic yards.	Tile drains, 223 linear yards.	Total cost of levee.
1	James N. Ogden, Baton Rouge, La	*Cts.* *20	*Cts.* *20	*Cts.* 30	$3,042.30	*Cts.* 22	*Cts.* 20	*Cts.* 30	$5,473.20	*Cts.* *23	*Cts.* 20	*Cts* 30	$1,233.10
2	Richard Rielly, Chicago, Ill	21½	21½	44	3,342.97	22½	20	44	5,743.94				

No.	Name and address of bidder.	Barataria levee district.							
		Concord.				Oakville, new and enlargement.			
		Embankment, 27,000 cubic yards.	Base, ditches, etc., 5,926 cubic yards.	Tile drains, 860 linear yards.	Total cost of levee.	Embankment, 28,160 cubic yards.	Base, ditches, etc., 6,000 cubic yards.	Tile drains, 1,516 linear yards.	Total cost of levee.
1	James N. Ogden, Baton Rouge, La	*Cts.* *20	*Cts.* 20	*Cts.* 30	$6,323.20	*Cts.* 19	*Cts.* 19	*Cts.* 30	$6,954.20
3	John Cleary, New Orleans, La	22	22	35	6,972.72				
4	Thomas C. Dennis, Jesuits Bend, La	21½	21½	39	6,855.49	23½	23½	39	8,630.54

	Barataria levee district.
Amount available (abstract F)	$25,433.64
Amount covered by this abstract	10,899.27
Balance	14,534.37

REMARKS.—Proposals marked thus (*), being the lowest and bidders responsible, are recommended **for acceptance.** Proposals for Fort St. Leon, Middle, and Oakville levees are not recommended for **acceptance,** owing to insufficiency of funds. Amount of work on least important levees to be limited **so as to enable more important work,** including revetment, to be completed.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 1, 1892.

N.—*Abstract of proposals received in response to advertisement dated October 25, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district.											
		Story, upper enlargement.				Story, lower new, and enlargement.				Repose.			
		Embankment, 5,000 cubic yards.	Base, ditches, etc. 1,000 cubic yards.	Tile drains, 433 linear yards.	Total cost of levee.	Embankment, 32,520 cubic yards.	Base, ditches, etc., 3,390 cubic yards.	Tile drains, 1,548 linear yards.	Total cost of levee.	Embankment, 13,200 cubic yards.	Base, ditches, etc., 904 cubic yards.	Tile drains, 485 linear yards.	Total cost of levee.
1	C. S. Jones, New Orleans, La	*Cts.* 32.49	*Cts.* 32.49	*Cts.* 40	$2,122.60	*Cts.* 32.49	*Cts.* 32.49	*Cts.* 40	$12,286.36	*Cts.* 32.49	*Cts.* 32.49	*Cts.* 40	$4,776.39
2	John Cleary, New Orleans, La									*23	*20	*35	3,386.55

	Lake Borgne levee district.
Amount available, Abstract K	$14,283.47
Amount covered by this abstract	3,386.55
Balance	10,896.92

REMARKS.—Proposals marked thus (*), being the lowest and bidder responsible, are recommended for acceptance. Proposals for Story, upper and lower levees, are recommended for rejection, being too high.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 5, 1892.

O.—*Abstract of proposals received in response to advertisement dated October 7, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district, left bank—Caernarvon.			
		Embankment, 30,000 cubic yards.	Base ditches, etc., 700 cubic yards.	Tile drains, 700 linear yards.	Total cost of levee.
		Cents.	*Cents.*	*Cents.*	
1	Patrick Harnan, New Orleans	28	25	59	$8,988.00
2	C. S. Jones, New Orleans	26.49	26.49	40	8,412.43
3	John Cleary, New Orleans	25	25	35	7,920.00

	Lake Borgne levee district.
Amount available, Abstract N	$10,896.92
Amount covered by this abstract	
Balance	10,896.92

REMARKS.—The proposal of John Cleary (No. 3) is the lowest received, but is not recommended for acceptance under allotment now available on account of insufficient funds to do this work, and that at Story Upper and Story Lower levees, which is regarded as of more importance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 15, 1892.

P.—***Abstract of proposals received in response to advertisement dated November 6, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.***

No.	Name and address of bidder.	Lake Borgne levee district.							
		Story, upper, enlargement.				Story, lower, new, and enlargement.			
		Embankment, 5,000 cubic yards.	Base ditches, etc., 1,000 cubic yards.	Tile drains, 433 linear yards.	Total cost of levee.	Embankment, 32,520 cubic yards.	Base ditches, etc., 3,300 cubic yards.	Tile drains, 1,548 linear yards.	Total cost of levee.
		Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*	
1	Columbus S. Jones, New Orleans, La	29.44	29.44	40	$1,939.60	29.44	29.44	40	$11,191.11
2	Robert McNamara, New Orleans, La	24.5	24.5	40	1,643.20	*30	*20	*40	11,053.20
3	Thomas O'Malley, Baton Rouge, La	26.5	50	25	2,033.25	28½	50	25	11,350.20
4	Noble W. Irish, Carlyle, Ill	31.5	17	28	1,866.24	31½	17	28	11,253.54
5	S. D. Moody & Co., limited, New Orleans, La	24.7	*17	*40	1,578.20	31	21	40	11,412.30

	Lake Borgne levee district, left bank.
Amount available, Abstract N	$10,896.92
Amount covered by this abstract	8,462.67
Balance	2,434.25

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance. It is proposed to limit the amount of work on Story Lower Levee to bring the total cost of levee work in the Lake Borgne district under the limits of the funds available. The lowest bidder, Mr. Robert McNamara, has given his written consent to this.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 19, 1892.

Q.—***Abstract of proposals received in reponse to advertisement dated November 11, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.***

No.	Name and address of bidder.	Ponchartrain levee district.			
		Lopez.		Jollsaint.	
		Embankment, 17,000 cubic yards.	Total cost of levee.	Embankment, 20,000 cubic yards.	Total cost levee of.
		Cents.		*Cents.*	
1	Columbus S. Jones, New Orleans, La	18.30	$3,111.00	18.30	$3,660.00
2	Homan, McFadden & Cassidy, Baton Rouge, La	20	3,400.00	21	4,200.00

	Ponchartrain levee district.
Amount available, Abstract L	$25,975.65
Amount covered by this abstract	6,771.00
Balance	19,204.65

REMARKS.—Proposal of Columbus S. Jones (No. 1) being the lowest received and considered reasonable, and bidder responsible, is recommended for acceptance. Bid No. 2 was received at 12 m., after the time set for opening.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 29, 1892.

R.—*Abstract of proposals received in response to advertisement dated December 19, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain levee district.					
		Towles.			Billings.		
		Embankment, 16,000 cubic yards.	Base ditches, etc., 80 cubic yards.	Total cost of levee.	Embankment, 37,700 cubic yards.	Base ditches, etc., 160 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	Columbus S. Jones, New Orleans, La..	22.40	10	$3,592.00	21.40	10	$8,083.80
2	Andrews Bros., Baton Rouge, La.....	23	16	3,692.80	20	20	7,572.00
3	E. W. Hanlon & Co., New Orleans, La.	*19.95	*15	3,204.00	*19.90	*15	7,526.30

	Pontchartrain levee district.
Amount available, Abstract Q	$19,204.65
Amount covered by this abstract	10,730.30
Balance	8,474.35

REMARKS.—Proposals marked thus (*) being lowest. and the bidder responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 19, 1892.

No. 1.—*Abstract of proposals received in response to advertisement dated November 28, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district.			Atchafalaya levee district.					
		Rifle Point, new and enlargement.			Belle Vale.			Rebecca.		
		Embankment, 35,000 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.	Embankment, 73,000 cubic yards.	Base ditches, etc., 190 cubic yards.	Total cost of levee.	Embankment, 92,000 cubic yards.	Base ditches, etc., 971 cubic yards.	Total cost of levee.
1	S. D. Moody & Co., Limited, New Orleans, La	*Cts.*	*Cts.*		*Cts.* 21½	*Cts.* 20	$15,733.00	*Cts.* 22	*Cts.* 20	$20,434.20
2	John Scott & Son, St. Louis, Mo				16.99	16.99	12,434.98	16.74	*16.74	15,563.34
3	W. J. Bentley & Co., New Orleans, La				*16¾	13	12,252.20	17½	14	16,235.94
4	Homan, McFadden & Cassidy, Baton Rouge, La				20	15	14,628.50	20½	18	19,034.78
6	E. W. Hanlon & Co., New Orleans, La	16.74	15	$5,934.00	23.8	20	17,412.00			
7	Robert Johnson, Memphis, Tenn				19½	19½	14,272.05	20	20	18,594.20
8	Rutherford & Dalgarn, Natchez, Miss	17.4	15½	6,167.50						
9	Isaac Henry, Millikens Bend, La	25	20	8,850.00	19	17	13,902.30	19	18	17,654.78
10	Alexander Eltringham, Natchez, Miss	16.75	16.75	5,946.25				28½	25½	26,407.60
11	Samuel L. James, Jr., Baton Rouge, La				16.99	16.99	12,434.98	19	19	17,664.49
12	W. F. Barbour & Co., Lucy P. O., La	†			(23¾ (23¾	(†) (†)	17,337.50 16,607.50	†		
13	James N. Ogden, Baton Rouge, La				20	20	14,638.00	21	21	19,523.91
15	Albert H. Gillespie, Vidalia, La	19.90	16	7,045.00						
16	J. S. McTighe & Co., Memphis, Tenn	*15.94	*15.94	5,658.70	18½	18½	13,540.15	20½	20½	19,059.05
17	W. L. Killebrew, Greenville, Miss	16.9	16.9	5,999.50	18½	18½	13,540.15	19.9	19.9	18,501.23
18	P. J. Coffman & Co., Baton Rouge, La				23	18	16,824.20			
19	Ernest Hyner, Greenville, Miss	21	16	7,430.00	18	18	13,174.20	18	18	16,734.78
20	James A. Andrews & Co., Baton Rouge, La				18.24	18.24	13,349.86	21¾	21¾	20,221.19
21	Jeffries & Dameron, Hester, La				18¾	18¾	13,723.12	20	20	18,594.20
22	Manning & Gibson, Natchez, Miss	16½	16½	5,857.50	20	20	14,638.00			
23	Green, Rogers & Co., New Orleans, La				20	10	14,619.00	22⅜	13½	20,716.08
24	Bogue & Co., Beulah, Miss				21.71	17	15,880.00	21.71	17	20,138.27

†No bid.

No. 1.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Atchafalaya levee district.			Barataria.					
		Missouri.			Fort St. Leon middle.			Oakville.		
		Embankment, 104,000 cubic yards.	Base ditches, etc., 424 cubic yards.	Total cost of levee.	Embankment, 18,700 cubic yards.	Base ditches, etc., 8,000 cubic yards.	Total cost of levee.	Embankment, 28,160 cubic yards.	Base ditches, etc., 5,600 cubic yards.	Total cost of levee.
1	S. D. Moody & Co., Limited, New Orleans, La	*Cts.* 21	*Cts.* 20	$21,924.80	*Cts.*	*Cts.*		*Cts.*	*Cts.*	
2	John Scott & Son, St. Louis, Mo	*16.99	*16.99	17,741.64						
3	W. J. Bentley & Co., New Orleans, La	17¼	14	17,999.36						
4	Homan, McFadden & Cassidy, Baton Rouge, La	21	18	21,916.32						
6	E. W. Hanlon & Co., New Orleans, La	28	25	29,226.00						
7	Robert Johnson, Memphis, Tenn	19	19	19,840.56						
9	Isaac Henry, Millikens Bend, La	17	15	17,743.60	19½	19½	$5,273.25	19½	19½	$6,667.60
10	Alexander Eltringham, Natchez, Miss	27½	25½	28,708.12	20½	20½	5,473.50	18½	18½	6,245.60
11	Samuel L. James, Jr., Baton Rouge, La	19	19	19,840.56						
12	W. F. Barbour & Co., Lucy P. O., La	22	(†)	22,880.00						
13	James N. Ogden, Baton Rouge, La				*20	*17	5,100.00	22	20	7,315.20
16	J. S. McTighe & Co., Memphis, Tenn	22.94	22.94	23,954.86	22	22	5,874.00	21.94	21.94	7,406.94
17	W. L. Killebrew, Greenville, Miss	20.9	20.9	21,824.62	27	27	7,209.00	*17.9	*17.9	6,043.04
18	P. J. Coffman & Co., Baton Rouge, La	27	18	28,156.32						
19	Ernest Hyner, Greenville, Miss	18	18	18,796.32						
20	James A. Andrews & Co., Baton Rouge, La	17.94	17.94	18,733.67						
21	Jeffries & Dameron, Hester, La	21	21	21,929.04						
23	Greene, Rogers & Co., New Orleans, La	23	11¼	23,967.70	20¼	19½	5,346.75	19½	19	6,625.60
24	Bogue & Co., Beulah, Miss	21.71	17	22,650.48						
25	Philip J. Reilly, New Orleans, La				22½	22½	6,074.25	22	22	7,427.20

† No bid.

No. 1.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Barataria levee district.								
		Star.			Ironton.			Oakland.		
		Embankment, 17,000 cubic yards.	Base ditches, etc., 7,000 cubic yards.	Total cost of levee.	Embankment, 6,200 cubic yards.	Base ditches, etc., 3,800 cubic yards.	Total cost of levee.	Embankment, 4,100 cubic yards.	Base ditches, to 2,100 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
5	H. B. Turcan, Jesuits Bend, La	21	21	$5,040.00						
9	Isaac Henry, Millikens Bend, La	*19¾	19¾	4,740.00	*19¾	*19¾	$1,975.00	*19¾	19¾	$1,224.50
10	Alexander Eltringham, Natchez, Miss	22⅜	20	5,205.75						
13	James N. Ogden, Baton Rouge, La	20	20	4,800.00	25	25	2,500.00	24	24	1,488.00
16	J. S. McTighe & Co., Memphis, Tenn	23	23	5,520.00	24½	24½	2,450.00	25	25	1,550.00
17	W. L. Killebrew, Greenville, Miss	22.9	22.9	5,496.00	25.9	25.9	2,590.00	25.9	25.9	1,605.80
23	Green, Rogers & Co., New Orleans, La	21½	19½	4,995.00	20¾	19½	2,027.50	20	19½	1,229.50
25	Philip J. Reilly, New Orleans, La	22	22	5,280.00	23	23	2,300.00	22	22	1,364.00

No.	Name and address of bidder.	Lake Borgne levee district.		
		Caernarvon.		
		Embankment, 32,000 cubic yards.	Base ditches, etc., 700 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
9	Isaac Henry, Millikens Bend, La	*19¾	19¾	$6,458.25
14	Patrick Harnan, New Orleans, La	24.9	24.9	8,142.30
16	J. S. McTighe & Co., Memphis, Tenn	25	25	8,175.00
17	W. L. Killebrew, Greenville, Miss	25	25	8,175.00
3	Green, Rogers & Co., New Orleans, La	25	20	8,140.00
25	Philip J. Reilly, New Orleans, La	24½	24½	8,011.50

REMARKS.—All proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

	Lower Tensas levee district.	Atchafalaya levee district.	Barataria levee district.	Lake Borgne levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894	$123,800.00	$136,800.00	$54,000.00	$45,000.00
Amount covered by this abstract	5,658.70	45,557.18	19,082.50	6,458.25
Balance	118,141.30	91,242.82	34,917.50	38,541.75

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 21, 1892.

NO. 2.—*Abstract of proposals received in response to advertisement dated November 28, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain levee district.								
		Shannon, lower.			Maryland.			Rescue.		
		Embankment 94,500 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.	Embankment 55,000 cubic yards.	Base ditches, etc., 250 cubic yards.	Total cost of levee.	Embankment 26,850 cubic yards.	Base ditches, etc., 150 cubic yards.	Total cost of levee.
1	Rutherford & Dalgarn, Natchez, Miss	*Cts.* 20½	*Cts.* 16	$19,216.25	*Cts.* 17½	*Cts.* 16	$9,665.00	*Cts.* 17	*Cts.* 15	$4,587.00
2	Manning & Gibson, Natchez, Miss	16.94	16.94	16,093.00	16.25	16.25	8,978.12	17.25	17.25	4,657.49
3	W. L. Killebrew, Greenville, Miss	17.9	17.9	17,005.00	15.9	15.9	8,784.75	17.9	17.9	4,833.00
4	Edmond P. White, New Orleans, La	20	20	19,000.00	20	20	11,050.00	.....	.....	.....
5	Homan, McFadden & Cassidy, Baton Rouge, La	16.4	16	15,578.00	17.8	16	9,830.00	18.7	16	5,044.95
6	Israel R. Bobbitt, Baton Rouge, La	.....	.....	.....	17½	15	9,662.50	18	15	4,855.50
7	Manoah V. Henry, Birmingham, Ala	*15	*13	14,240.00	15½	14	8,560.00	15.99	14	4,314.32
8	Thos. O'Malley, Baton Rouge, La	19¾	19¾	18,762.50	22	22	12,155.00	22	22	5,940.00
9	J. S. McTighe & Co., Memphis, Tenn	19	19	18,050.00	17½	17½	9,668.75	17½	17½	4,725.00
10	Ovide Lacour, Raccourci P. O., La	19.99	10	18,940.55	16.45	10	9,072.50	.....	.....	.....
11	W. H. O'Connell, New Texas P. O., La	.....	.....	.....	17.85	17.85	9,862.12	.....	.....	.....
12	G. W. Reagan, Red River Landing, La	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	Jas. N. Ogden, Baton Rouge, La	19.9	19.9	18,905.00	19.9	19.9	10,994.75	19.9	19.9	5,373.00
14	S. L. James, jr., Baton Rouge, La	15.99	15.99	15,190.50	16	16	8,840.00	.....	.....	.....
15	H. C. Brown, New Orleans, La	17.24	17.24	16,378.00	16.40	12	9,050.00	21	21	5,670.00
16	Jno. Scott & Son, Baton Rouge, La	20½	20½	19,475.00	17.45	17.45	9,641.12	18	18	4,860.00
17	E. W. Hanlon & Co., New Orleans, La	17.35	15	16,470.75	15.85	10	8,742.50	16	10	4,311.00
18	Alex. Eltringham, Natchez, Miss	16.45	14	15,615.25	*14.73	*14.73	8,138.32	15	15	4,050.00
19	P. J. Coffman & Co., Baton Rouge, La	18.94	14	17,968.30	18.94	14	10,452.00	21	16	5,662.50
20	Jeffries & Dameron, Hester, La	17½	17½	16,625.00	15	15	8,287.50	18	18	4,860.00
21	W. F. Barbour & Co., Lucy P. O., La	20½	20½	19,712.50	17½	17½	9,668.75	16½	16.20	4,374.00
22	McLaughlin Bros., Memphis, Tenn	20½	20	19,236.25	18½	18½	10,221.25	20	20	5,400.00
23	Greene, Rogers & Co., New Orleans, La	20½	10	19,422.50	17.45	10	9,622.50	16.94	10	4,563.39
24	W. L. Withers, Victoria, Miss	19	15	18,050.00	18½	15	10,212.50	18¾	15	5,056.87
25	S. D. Moody & Co., limited, New Orleans, La	.....	.....	.....	14.95	14.95	8,259.87	15.95	15.95	4,306.49
26	Jas. A. Andrews & Co., Baton Rouge, La	16.94	16.94	16,093.00	23.50	16	12,965.00	20	20	5,400.00
27	Edw. D. Leche, Island P. O., La	.....	.....	.....	18	18	9,945.00	.....	.....	.....

No. 2.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.								
		Southward, upper.			Belle Helene.			Houmas.		
		Embankment, 32,850 cubic yards.	Base ditches, etc., 150 cubic yards.	Total cost of levee.	Embankment, 53,000 cubic yards.	Base ditches, etc., 255 cubic yards.	Total cost of levee.	Embankment, 31,000 cubic yards.	Base ditches, etc., 166 cubic yards.	Total cost of levee.
1	Rutherford & Dalgarn, Natchez, Miss	Cts. 17.9	Cts. 16	$5,904.15	Cts. 16.40	*15	$8,730.25	Cts. 17.90	Cts. 16	$5,575.56
2	Manning & Gibson, Natchez, Miss	18	18	5,940.00						
3	W. L. Killebrew, Greenville, Miss	17.9	17.9	5,907.00	22.9	22.9	12,720.95	16⅜	16⅜	5,103.43
4	Edmond P. White, New Orleans La							18½	15	5,759.90
5	Homan, McFadden & Cassidy, Baton Rouge, La	19.5	16	6,429.75	36	25	19,143.75			
6	Israel R. Pobbitt, Baton Rouge, La	18½	15	6,099.75				16.75	15	5,217.40
7	Manoah V. Henry, Birmingham, Ala	16	14	5,277.00	27	27	14,378.85	15½	13	4,826.58
8	Thos. O'Malley, Baton Rouge, La	22	22	7,260.00	22	22	11,716.10	22	22	6,856.52
9	J. S. McTighe & Co., Memphis, Tenn	19½	19½	6,435.00	28	28	14,911.40	16.99	16.99	5,295.10
10	Ovide Lacour, Raccourci P. O., La	19.99	10	6,581.72				17.74	10	5,516.00
11	W. H. O'Connell, New Texas P. O., La									
12	G. W. Reagan, Red River Landing, La							16½	15	5,139.90
13	Jas. N. Ogden, Baton Rouge, La	17.9	17.9	5,907.00				19.9	19.9	6,202.03
14	S. L. James, jr., Baton Rouge, La				22	22	11,716.10	16	16	4,986.56
15	H. C. Brown, New Orleans, La	21	21	6,930.00	33	33	17,574.15	20	20	6,233.20
16	Jno. Scott & Son, Baton Rouge, La	16.99	16.99	5,606.70	22	22	11,716.10	19	19	5,921.54
17	E. W. Hanlon & Co., New Orleans, La	15.90	10	5,238.15						
18	Alex. Eltringham, Natchez, Miss	*15.43	*14	5,089.75	16.93	15½	9,011.78	*15.43	*14	4,806.54
19	P. J. Coffman & Co., Baton Rouge, La	21	18	6,925.50	29.75	20	15,818.50	19.75	17	6,150.72
20	Jeffries & Dameron, Hester, La	18	18	5,940.00	22	22	11,716.10	16	16	4,986.56
21	W. F. Barbour & Co., Lucy P. O., La	17	17	5,610.00	18.7	18.7	9,958.68	19	19	5,921.54
* 22	McLaughlin Bros., Memphis, Tenn	19	15	6,264.00	23	20	12,241.00	18½	18½	5,765.71
23	Greene, Rogers & Co., New Orleans, La	17⅞	10	5,845.88	22½	10	11,950.50	16	10	4,976.60
24	W. L. Withers, Victoria, Miss	19.99	15	6,589.21				19¼	14	5,990.74
25	S. D. Moody & Co., limited, New Orleans, La	17.95	17.95	5,923.51				16.95	16.95	5,282.64
26	Jas. H. Andrews & Co., Baton Rouge, La	18.24	18.24	6,019.20	25¼	16	13,688.30	17½	17½	5,376.13
27	Edw. D. Leche, Island P. O., La									

	Pontchartrain levee district.
Allotment from appropriations to be made for fiscal year ending June 30, 1894	$135,000.00
Amount covered by this abstract	45,054.86
Balance	89,945.14

REMARKS.—All proposals marked thus (*) being the lowest, and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 23, 1892.

No. 3.—*Abstract of proposals received in response to advertisement dated November 28, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lafourche Levee District.					
		Melançon–Lemanville.			Jamestown, lower.		
		Embankment 55,000 cubic yards.	Base ditches, etc., 200 cubic yards.	Total cost of levee.	Embankment 38,350 cubic yards.	Base ditches, etc., 150 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	W. F. Barbour & Co., Lucy, La	15.94	15.94	$8,798.88	16.74	16.74	$6,444.90
2	Jas. A. Andrews & Co., Baton Rouge, La	21	16	11,582.00	17.74	14	6,824.29
3	Isaac Henry, Millikens Bend, La	19½	19½	10,764.00	19½	19½	7,507.50
4	W. L. Killebrew, Greenville, Miss	16.9	16.9	9,328.80	16.9	16.9	6,506.50
5	McLaughlin Bros., Memphis Tenn	19¾	19¾	10,902.00	20½	20½	7,892.50
6	Jeffries & Dameron, Hester, La	15	15	8,280.00	17	17	6,545.00
7	J. S. McTighe & Co., Memphis, Tenn	17	17	9,384.00	18½	18½	7,122.50
8	E. W. Hanlon & Co., New Orleans, La	15.9	12	8,769.00	17.95	12	6,901.82
9	Greene, Rogers & Co., New Orleans, La	17½	10	9,507.50	18½	10	7,013.87
10	S. D. Moody & Co., limited, New Orleans, La	14.94	14.94	8,246.88	15.94	15.94	6,136.91
11	Homan, McFadden & Cassidy, Baton Rouge, La	15½	15½	8,418.00	16¾	16¾	6,448.74
12	Alex. Eltringham, Natchez, Miss	14.25	12	7,861.50	16.24	14	6,249.04
13	Ovide Lacour, Raccourci, La	*14	*10	7,720.00	*14.95	*10	5,748.32
14	Jas. N. Ogden, Baton Rouge, La	17.9	17.9	9,880.80	16.9	16.9	6,506.50
15	Thos. O. Malley, Baton Rouge, La	19½	19½	10,764.00	19½	19½	7,507.50

	Lafourche levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894	$81,000.00
Amount covered by this abstract	13,468.32
Balance	67,531.68

REMARKS.—All proposals marked thus (*) being lowest, and bidder responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 6, 1893.

No. 4.—***Abstract of proposals received in response to advertisement dated December 15, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.***

No.	Name and address of bidder.	Pontchartrain Levee district.								
		Hester.			St. Elmo.			Poche.		
		Embankment, 130,500 cubic yards.	Base ditches, etc., 980 cubic yards.	Total cost of levee.	Embankment, 36,000 cubic yards.	Base ditches, etc., 248 cubic yards.	Total cost of levee.	Embankment, 24,500 cubic yards.	Base ditches, etc., 85 cubic yards.	Total cost of levee.
1	S. D. Moody & Co. limited, New Orleans, La	*Cts.* *15½	*Cts.* 15½	$20,360.80	*Cts.* 15¾	*Cts.* 15¾	$5,709.06	*Cts.* 16	*Cts.* 16	$3,933.60
2	J. N. Ogden, Baton Rouge, La	15.99	15.99	21,004.46	16.99	16.99	6,158.54	17	17	4,179.45
3	Robt. Johnson, Memphis, Tenn	18	18	23,614.80	17	17	6,162.16	19	19	4,671.15
4	McLaughlin Bros., Memphis, Tenn	16¾	15	21,987.75	16½	15	5,977.20	16½	15	4,055.25
5	W. J. Bentley & Co., New Orleans, La	16.7	15	21,922.50	16.7	15	6,049.20	22	15	5,402.75
6	Greene, Rogers & Co., New Orleans, La	18½	13	24,254.30	18	13	6,512.24	16	11	3,929.35
7	Israel R. Bobbitt, Burnside, La	16.90	15	22,188.50	17.40	15	6,301.20	15½	15	3,810.25
8	E. P. White, New Orleans, La	20	20	26,272.00	18	18	6,524.64	16	16	3,935.60
9	Andrews Bros. Construction Co., Baton Rouge, La	19½	14	25,241.65	19¾	15	7,147.20	16½	14	3,933.15
10	Homan, McFadden & Cassidy, Baton Rouge, La	19.8	18	25,993.80	17.3	17.3	6,270.90	16.2	16.2	3,982.77
11	A. P. Martin, Waterproof, La	20	20	26,272.00	19	19	6,887.12	18	18	4,425.30
12	Ovide Lacour, New Orleans, La	21	15	27,534.00	19.95	15	7,219.20	19.95	15	4,900.50
13	Sterling Fort, Greenville, Miss							16.9	16	4,154.10
14	W. H. O'Connell, New Texas, La	26½	26½	34,810.40						
15	S. L. James, jr., Baton Rouge, La							17	17	4,179.45
16	Jeffries & Dameron, Hester, La	16¾	16¾	22,002.80	16	16	5,799.68	15	15	3,687.75
17	P. Harnan, New Orleans, La				24½	20	8,869.60	22	20	5,407.00
18	Chas. T. Worthington, Leota, Miss	15½	15	20,682.75						
19	E. W. Hanlon & Co., New Orleans, La	16.89	15	22,160.45	16.49	15	5,973.60	15.9	13	3,906.55

	Pontchartrain levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract 2	$89,945.14
Amount covered by this abstract	29,757.61
Balance	60,187.53

REMARKS.—Proposals marked thus, (*) being the lowest and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 7, 1893.

No. 5.—*Abstract of proposals received in response to advertisement dated December 15, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lafourche Levee district.					
		St. Emma.			Magnolia.		
		Embankment, 53,000 cubic yards.	Base ditches, etc., 160 cubic yards.	Total cost of levee.	Embankment, 43,000 cubic yards.	Base ditches, etc., 95 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	Israel R. Bobbitt, Burnside, La	10½	15	$8,901.50	17.44	15	$7,513.45
2	Homan, McFadden, & Cassidy, Baton Rouge, La	18	15	7,564.00	18	15	7,754.25
3	Sterling Fort, Greenville, Miss	15.9	15	8,451.00	15.9	15	6,851.25
4	Andrews Bros. Construction Co., Baton Rouge, La	16½	14	8,634.90	18½	14½	7,861.27
5	Edmond P. White, New Orleans, La	18	18	9,568.80	15	15	6,464.25
6	W. J. Bentley & Co., New Orleans, La	16.7	15	8,875.00	17.7	15	7,625.25
7	C. D. Leeper & Co., Baton Rouge, La				22½	25	9,698.75
8	P. J. Coffman & Co., Baton Rouge, La	21	18	11,158.80			
9	P. Harnan, New Orleans, La	23	20	12,222.00	23	20	9,909.00
10	Jeffries & Dameron, Hester, La	16	16	8,505.60	16½	16½	7,110.67
11	Chas. T. Worthington, Leota, Miss	*14½	*14	7,707.40	14½	14	6,248.30
12	E. W. Hanlon & Co., New Orleans, La	15.9	13	8,447.80	*14.49	*13	6,243.05
13	Greene, Rogers & Co., New Orleans, La	18½	12½	9,825.00	18½	12½	7,859.61
14	Isaac Henry, Milliken's Bend, La	22	22	11,695.20	21	21	9,049.95

	Lafourche Levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 3	$67,531.68
Amount covered by this abstract	13,950.45
Balance	53,581.23

REMARKS—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 9, 1893.

NO. 6.—*Abstract of proposals received in response to advertisement dated December 23, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain Levee district. Terre Haute. Embankment, 48,500 cubic yards.	Terre Haute. Base ditches, etc., 300 cubic yards.	Terre Haute. Total cost of levee.	Prospect. Embankment, 50,500 cubic yards.	Prospect. Base ditches, etc., 300 cubic yards.	Prospect. Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	James Cotten, Raccourci, La	23½	23½	$11,468.00	23½	23½	$11,959.15
2	Jas. N. Ogden, Baton Rouge, La	16.9	16.9	8,247.20	16.9	16.9	8,600.41
3	Edmund P. White, New Orleans, La	18	15	8,775.00	22	22	11,195.80
4	E. W. Hanlon & Co., New Orleans, La	17.9	15	8,726.50	17	15	8,643.50
5	Israel R. Bobbitt, Burnside, La	15½	15	7,562.50	18¼	15	9,274.75
6	H. C. Brown, New Orleans, La	*14.90	*10	7,256.50	17.40	10	8,826.00
7	Andrews Bros. Construction Co., Baton Rouge, La	15.49	15.49	7,559.12	17⅞	17⅞	9,032.97
8	Greene, Rogers & Co., New Orleans, La	17½	11½	8,521.25	18½	11½	9,387.35
9	Homan, McFadden & Cassidy, Baton Rouge, La	15¾	15¾	7,686.00	*16	*16	8,142.40
10	Isaac Henry, Millikins Bend, La	20½	20½	10,004.00	20½	20½	10,432.45
11	Jeffries & Dameron, Hester, La	17	17	8,296.00	20	20	11,188.00
12	F. A. Brock, Galveston, Tex	23	23	11,224.00	22	22	11,195.80
13	P. J. Reilly, New Orleans, La	18½	18½	8,906.00	.....	.....	.....
14	P. J. Coffman & Co., Baton Rouge, La.	17¾	16	8,656.75	19½	16	9,909.90
15	S. L. James, jr., Baton Rouge, La	18	18	8,784.00	.....	.....	.....

No.	Name and address of bidder.	Lafourche Levee district. White Rose. Embankment, 21,200 cubic yards.	White Rose. Base ditches, etc., 70 cubic yards.	White Rose. Total cost of levee.	Barataria Levee district. Belle Chasse. Embankment, 71,800 cubic yards.	Belle Chasse. Base ditches, etc., 1,800 cubic yards.	Belle Chasse. Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	James Cotten, Raccourci, La	25	25	$5,317.50	23	23	$16,928.00
2	Jas. N. Ogden, Baton Rouge, La	20	20	4,254.00	18.45	18.45	13,579.20
3	Edmund P. White, New Orleans, La	18	18	3,828.60	.....	.....	.....
4	E. W. Hanlon & Co., New Orleans, La	15.95	13	3,390.50	22	15	16,066.00
5	Israel R. Bobbitt, Burnside, La	18	15	3,826.50	.....	.....	.....
6	H. C. Brown, New Orleans, La	17.29	10	3,672.48	*14.87	*10	10,856.66
7	Andrews Bros. Construction Co., Baton Rouge, La	17.24	17.24	3,666.95	.....	.....	.....
8	Greene, Rogers & Co., New Orleans, La	18	10	3,823.00	.....	.....	.....
9	Homan, McFadden & Cassidy, Baton Rouge, La	17	17	3,615.90	.....	.....	.....
10	Isaac Henry, Millikens Bend, La	24	24	5,104.80	26	26	19,136.00
11	Jeffries & Dameron, Hester, La	*15	*15	3,190.50	.....	.....	.....
12	F. A. Brock, Galveston, Tex	24	24	5,104.80	20	20	14,720.00
13	P. J. Reilly, New Orleans, La	.....	.....	.....	20	18	14,684.00
14	P. J. Coffman & Co., Baton Rouge, La	19⅛	15	4,144.50	21	21	15,456.00
15	S. L. James, jr., Baton Rouge, La	18	18	3,828.60	.....	.....	.....

	Pontchartrain Levee district.	Lafourche Levee district.	Barataria Levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:			
Amount available, Abstracts 4, 5 and 1	†$131,312.25	‡$53,581.23	§$38,541.75
Amount covered by this abstract	15,398.90	3,190.50	10,856.66
Balance	115,913.35	50,390.73	27,685.09

† Abstract 4. ‡ Abstract 5. § Abstract 1.

REMARKS.—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 9, 1893.

No. 7.—*Abstract of proposals received in response to advertisement dated December 15, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Atchafalaya levee district.								
		St. Francis Church.			Dunboine, upper.			Belle Grove.		
		Embankment, 33,000 cubic yards.	Base ditches, etc., 255 cubic yards.	Total cost of levee.	Embankment, 45,000 cubic yards.	Base ditches, etc., 240 cubic yards.	Total cost of levee.	Embankment, 57,000 cubic yards.	Base ditches, etc., 235 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	Ovide Lacour, Raccourci, La	18.49	15	$6,136.95	18	15	$8,136.00	17.74	15	$10,147.05
2	W. J. Bentley & Co., New Orleans, La				17	17	7,690.80	16	16	9,157.60
3	Noble W. Irish, Carlyle, Ill				21	17	9,490.80	21	17	12,009.95
4	Donovan, Daley & Co., St. Gabriel, La	19	13	6,300.55	15.99	13	7,217.70	15.97	13	9,133.45
5	W. L. Killebrew, Greenville, Miss	16⅝	15	5,439.00	14.99	14	6,788.60	15.75	15	9,012.75
6	Jas. N. Ogden, Baton Rouge, La	20	20	6,647.00	18	18	8,143.20	18	18	10,302.30
7	Geo. M. D. Grigsby, Jefferson, Tex				*14.73	*14¼	6,662.70	*14.73	*14¼	8,429.50
8	Andrews Bros. Construction Co., Baton Rouge, La	15.74	15.74	5,231.19	16.94	16.94	7,663.66	16.94	14	9,688.70
9	Edmund P. White, New Orleans, La	17	17	5,649.95						
10	A. P. Martin, Waterproof, La	19	19	6,314.65	19½	19½	8,821.80	18½	18½	10,588.47
11	Jeffries & Dameron, Hester, La	17	17	5,649.95	15	15	6,786.00	15½	15½	8,871.42
12	Greene, Rogers & Co., New Orleans, La				16¾	12½	7,566.90	17⅛	11⅛	9,788.27
13	S. L. James, Baton Rouge, La	18	18	5,982.30	18	18	8,143.20			
14	W. H. O'Connell, New Texas, La	27¾	27¾	9,222.71						
15	E. W. Hanlon & Co., New Orleans, La	15.99	14	5,309.60	18.50	15	8,361.00	21	15	12,005.25
16	Jos. S. McLaughlin, Memphis, Tenn	17	14	5,642.90	16½	16	7,463.40	16½	16	9,442.60
17	Manning & Gibson, Natchez, Miss	*15	*15	4,985.25	15½	15½	7,012.20	16½	16½	9,443.78
18	Homan, McFadden & Cassidy, Baton Rouge, La	17	15	5,645.25	18	18	8,143.20	16½	16½	9,443.78

No. 7.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Atchafalaya levee district.							
		Celeste.		Mount Salem.			Babin.		
		Embankment, 20,500 cubic yards.	Total cost of levee.	Embankment, 8,000 cubic yards.	Base ditches, etc 185 cubic yards.	Total cost of levee.	Embankment, 13,000 cubic yards.	Base ditches, etc., 40 cubic yards.	Total cost of levee.
		Cts.		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	Ovide Lacour, Raccourci, La	15.75	$4,803.75	15.49	15	$2,815.95	15.99	15	$2,084.70
2	W. J. Bentley & Co., New Orleans, La	16	4,880.00	16	16	2,909.60			
4	Donovan, Daley & Co., St. Gabriel, La	15.47	4,718.35	15.97	13	2,898.65	19	13	2,575.20
5	W. L. Killebrew, Greenville, Miss	*14.99	4,571.95	*14.94	*14	2,715.10	15½	15	2,004.75
6	Jas. N. Ogden, Baton Rouge, La	16	4,880.00	18	18	3,273.30	18	18	2,347.20
8	Andrews Bros. Construction Co., Baton Rouge, La			16.99	14½	3,083.50	17¼	17¼	2,249.40
9	Edmund P. White, New Orleans, La	17	5,185.00	17	17	3,091.45			
10	A. P. Martin, Waterproof, La	18¾	5,718.75	18¾	18¾	3,409.66	18	18	2,347.20
11	Jeffries & Dameron, Hester, La	15	4,575.00	15	15	2,727.75	*15	*15	1,956.00
12	Greene, Rogers & Co., New Orleans, La	17	5,185.00	18	10	3,258.50	18	10	2,344.00
13	S. L. James, Baton Rouge, La	18	5,490.00	18	18	3,273.30			
15	E. W. Hanlon & Co., New Orleans, La	16	4,880.00	16	13	2,904.05	16	13	2,085.20
16	Jos. S. McLaughlin, Memphis, Tenn	16½	5,033.30	16½	16	2,929.60	16½	16	2,151.40
17	Manning & Gibson, Natchez, Miss	15½	4,727.50	15½	15½	2,818.67	15½	15½	2,021.20
18	Homan, McFadden & Cassidy, Baton Rouge, La	15.8	4,819.00	15	15	2,727.75			

	Atchafalaya levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 1	$91,242.82
Amount covered by this abstract	29,320.59
Balance	61,922.23

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 11, 1893.

No. 8.—*Abstract of proposals received in response to advertisement dated December 28, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lafourche levee district.					
		Providence.			Flagtown.		
		Embankment, 49,900 cubic yards.	Base ditches, etc., 226 cubic yards.	Total cost of levee.	Embankment, 17,000 cubic yards.	Base ditches, etc., 171 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	E. W. Hanlon & Co., New Orleans, La.	14.99	13	$7,509.39	15.49	13	$2,655.53
2	C. D. Leeper & Co., Baton Rouge, La.	18.70	10	9,353.90	.....	.....	.....
3	P. J. Reilly, New Orleans, La	18	14	9,013.64	18	14	3,083.94
4	Ovide Lacour, Raccourci, La	16	16	8,020.16	16	16	2,747.36
5	Jeffries & Dameron, Hester, La	18	18	9,022.68	16	16	2,747.36
6	Isaac Henry, Millikens Bend, La.....	25	25	12,551.50	25	25	4,292.75
7	W. L. Killebrew, Greenville, Miss.....	15⅜	14	7,703.76	15	14	2,573.94
8	Andrews Bros. Construction Co., Baton Rouge, La.....	14.94	14.94	7,488.82	*14.94	*14.94	2,565.34
9	Geo. M. D. Grigsby, Jefferson, Tex.....	*14.77	*14.77	7,403.61	15.88	15.88	2,726.75
10	J. A. Carson & Co., Baton Rouge, La ..	16	16	8,020.16	17	17	2,919.07
11	Israel R. Bobbitt, Burnside, La	15.40	15	7,718.50	15.40	15	2,643.65
12	C. S. Jones, New Orleans, La.....	14.81	14	7,421.83	16.20	16	2,781.36
13	E. P. White, New Orleans, La	20	15	10,013.90	20	15	3,425.65
14	Greene, Rogers, & Co., New Orleans, La	17¼	10	8,630.35	17⅛	10	2,992.10
15	J. N. Ogden, Baton Rouge, La	16.9	16.9	8,471.29	18.9	18.9	3,245.31

No.	Name and address of bidder.	Lafourche levee district.					
		Speranza.			Ashton.		
		Embankment 14,500 cubic yards.	Base ditches, etc., 114 cubic yards.	Total cost of levee.	Embankment 36,000 cubic yards.	Base ditches, etc., 316 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	E. W. Hanlon & Co., New Orleans, La.	15.49	13	$2,260.87	15	13	$5,441.08
2	C. D. Leeper & Co., Baton Rouge, La..	.....	.....	.....	18	12	6,517.92
3	P. J. Reilly, New Orleans, La	17.7	14	2,582.46	17.7	14	6,416.24
4	Ovide Lacour, Raccourci, La	16	16	2,338.24	16	16	5,810.56
5	Jeffries & Dameron, Hester, La.....	17	17	2,484.38	17½	17	6,353.72
6	Isaac Henry, Millikens Bend, La	25	25	3,653.50	25	25	9,079.00
7	W. L. Killebrew, Greenville, Miss.....	15	14	2,190.96	15⅜	14	5,579.24
8	Andrews Bros. Construction Co., Baton Rouge, La.....	*14.74	*14.74	2,154.10	15.44	15.44	5,607.19
9	Geo. M. D. Grigsby, Jefferson, Tex.....	15.99	15.99	2,336.77	*14.77	*14.77	5,363.87
10	J. A. Carson & Co., Baton Rouge, La ..	18	18	2,630.52	17	17	6,173.72
11	Israel R. Bobbitt, Burnside, La.....	16½	15	2,373.35	15⅛	15	5,627.40
12	C. S. Jones, New Orleans, La	16.20	16.12	2,367.37	17.40	17	6,317.72
13	E. P. White, New Orleans, La	20	15	2,917.10	20	15	7,247.40
14	Greene, Rogers, & Co., New Orleans, La	18½	11	2,695.04	18⅛	13	6,701.08
15	J. N. Ogden, Baton Rouge, La	18.9	18.9	2,762.04	17.9	17.9	6,500.56

	Lafourche levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 5	$67,049.55
Amount covered by this abstract.....	17,488.90
Balance.....	49,560.65

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 4, 1893.

No. 9.—***Abstract of proposals received in response to advertisement dated January 24, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.***

No.	Name and address of bidder.	Barataria levee district.					
		Magnolia, new and enlargement.			Kearney.		
		Embankment, 19,933 cubic yards.	Base ditches, etc., 810 cubic yards.	Total cost of levee.	Embankment, 20,634 cubic yards.	Base ditches, etc., 677 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	Johnson & Sullivan, Memphis, Tenn..	21	21	$4,356.03	21½	21½	$4,581.86
2	J. F. Coleman, New Orleans, La.....	24	24	4,978.32	20	20	4,262.20
3	Philip J. Reilly, New Orleans, La.....	18	18	3,733.74	18	18	3,835.98
4	C. S. Jones, New Orleans, La.....	19.40	19.40	4,024.14	.....	.....	.....
5	Chas. P. Worthington, Leota, Miss.....	21	20	4,347.93	21	20	4,468.54
6	W. L. Killebrew, Greenville, Miss	.....	.....	.....	19.9	15	4,207.73
7	E. W. Hanlon & Co., New Orleans, La.	24	15	4,905.42	16.94	14	3,590.18
8	Jeffries & Dameron, Hester, La.....	*15	*15	3,111.45	*14¾	*14¾	3,143.37
9	Greene, Rogers & Co., New Orleans, La.	21	15	4,307.43	25	15	5,260.05
10	Frank M. McLaughlin, Memphis, Tenn.	16½	16½	3,422.59	16¾	16¾	3,569.59

No.	Name and address of bidder.	Barataria levee district.				
		St. Anne enlargement.		Dobard.		
		Embankment, 8,000 cubic yards.	Total cost of levee.	Embankment, 20,590 cubic yards.	Base ditches, etc., 965 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	*Cents.*	
1	Johnson & Sullivan, Memphis, Tenn...	23	$1,840.00	20½	20½	$5,579.88
2	J. F. Coleman, New Orleans, La.....	25	2,000.00	20	20	5,511.00
3	Philip J. Reilly, New Orleans, La.....	18¾	1,500.00	18½	18½	5,097.67
4	C. S. Jones, New Orleans, La.....	.....	.....	19.40	19.40	5,345.67
5	Chas. P. Worthington, Leota, Miss	22	1,760.00	21	20	5,776.90
6	W. L. Killebrew, Greenville, Miss.....	17.9	1,432.00	20.9	18	5,731.01
7	E. W. Hanlon & Co., New Orleans, La..	24	1,920.00	16.94	14	4,639.45
8	Jeffries & Dameron, Hester, La.....	25	2,000.00	*15	*15	4,133.25
9	Greene, Rogers & Co., New Orleans, La.	22	1,760.00	19	16	5,206.50
10	Frank M. McLaughin, Memphis, Tenn.	38	3,040.00	17.99	17.99	4,957.14

	Barataria levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 6	$43,143.34
Amount covered by this abstract	11,820.07
Balance	31,323.27

REMARKS.—Proposals marked thus (*) being the lowest and the bidders considered responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 4, 1893.

No. 10.—*Abstract of proposals received in response to advertisement dated January 24, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district.								
		Battle Ground, new and enlargement.			Irving.			Orange Grove.		
		Embankment, 24,075 cubic yards.	Base ditches, etc., 1,052 cubic yards.	Total cost of levee.	Embankment, 44,864 cubic yards.	Base ditches, etc., 1,847 cubic yards.	Total cost of levee.	Embankment, 15,777 cubic yards.	Base ditches, etc., 684 cubic yards.	Total cost of levee.
1	Johnson & Sullivan, Memphis, Tenn	*Cts.* 23	*Cts.* 23	$5,779.21	*Cts.* 27½	*Cts.* 27½	$12,845.52	*Cts.* 21	*Cts.* 21	$3,456.81
2	J. F. Coleman, New Orleans, La	22	22	5,527.94	24	24	11,210.64	22	22	3,621.42
4	Philip J. Reilly, New Orleans, La	18¼	18¼	4,585.68	18¼	18¼	8,524.76	19	19	3,127.59
5	C. S. Jones, New Orleans, La	.....	.....	.....	22	22	10,276.42	19	19	3,127.59
6	Charles T. Worthington, Leota, Miss	23	20	5,747.65	22	20	10,239.48	22	20	3,607.74
7	W. L. Killebrew, Greenville, Miss	.....	.....	.....	.....	.....	.....	21	18	3,436.29
8	E. W. Hanlon & Co., New Orleans, La	18.4	13	4,566.56	20	15	9,249.85	16.74	12	2,723.15
9	Jeffries & Dameron, Hester, La	18	18	4,522.86	19⅞	19⅞	9,283.81	*16	*16	2,633.76
10	Greene, Rogers & Co., New Orleans, La	21	21	5,276.67	20½	19	9,548.05	21	15	3,415.77
11	John Cleary, New Orleans, La	18	.....	4,333.50	18	.....	8,075.52	.....	.....	.....
12	Frank M. McLaughlin, Memphis, Tenn	*17¼	*17¼	4,334.41	22	22	10,276.42	17	17	2,798.37

No.	Name and address of bidder.	Lake Borgne levee district.								
		English Turn.			St. Clair.			Mon Plaisir.		
		Embankment, 24,555 cubic yards.	Base ditches, etc., 1,085 cubic yards.	Total cost of levee.	Embankment, 28,500 cubic yards.	Base ditches, etc., 2,403 cubic yards.	Total cost of levee.	Embankment, 14,600 cubic yards.	Base ditches, etc., 1,045 cubic yards.	Total cost of levee.
1	Johnson & Sullivan, Memphis, Tenn	*Cts.* 19½	*Cts.* 19½	$4,938.40	*Cts.* 20½	*Cts.* 20½	$6,335.11	*Cts.* 21	*Cts.* 21	$3,285.45
2	J. F. Coleman, New Orleans, La	20	20	5,128.00	20	20	6,180.60	21	21	3,285.45
3	James Byrne, Baton Rouge, La	22½	22½	5,768.99	.....	.....	.....	22½	22½	3,520.12
4	Philip J. Reilly, New Orleans, La	15½	15½	3,974.19	14.91	14.91	4,607.64	15.4	15.4	2,409.33
6	Charles T. Worthington, Leota, Miss	22	20	5,619.10	23	20	7,035.60	23	20	3,567.00
7	W. L. Killebrew, Greenville, Miss	18.99	15	4,825.74	27	27	8,343.81	16.9	16.9	2,644.00
8	E. W. Hanlon & Co., New Orleans, La	16.74	12	4,240.71	16.74	12	5,059.26	16.74	12	2,569.44
9	Jeffries & Dameron, Hester, La	*14½	*14½	3,717.79	*14	*14	4,326.42	*14	*14	2,190.30
10	Greene, Rogers & Co., New Orleans, La	19	17	4,849.90	19	19	5,871.57	19	15	2,930.75
12	Frank M. McLaughlin, Memphis, Tenn	16½	16½	4,230.59	16.73	16.73	5,170.07	17	17	2,659.65

No. 10.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

	Lake Borgne levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 1	$38,541.75
Amount covered by this abstract	25,555.25
Balance	12,986.50

REMARKS.—Proposals marked thus (*) being the lowest regular bids and the bidders considered responsible, are recommended for acceptance. Bid of John Cleary incomplete.

The reports of assistants in local charge of the different levee districts are as follows:

REPORT OF ASSISTANT ENGINEER DOUGLAS, IN LOCAL CHARGE OF THE LOWER TENSAS LEVEE DISTRICT.

NATCHEZ, MISS., *May 30, 1893.*

SIR: I have the honor to submit the following report on the work under my local charge for the period from June 1, 1892, to May 30, 1893:

LOWER TENSAS DISTRICT LEVEES.

Construction.—At date of last report no work was in progress, all levee construction undertaken having been completed.

The general condition of the work was fair, as has been proved by the passing of the flood of 1892 without a break in the line of levees. Some levees were threatened by caving banks and others were deficient in section or low in grade.

During the past season the construction or extensive enlargement of 22.4 miles of levees was undertaken. Of this, 6.5 miles was new embankment and 15.9 miles raising and enlargement of existing levees.

The special features of construction of levee embankments this season have been the limited use of muck ditches, the cutting down or leveling off of old levees before enlargement, the variation of the land slope in proportion to the height, and the use of tile drains to carry off seepage water from the toe of the land slope.

All the conditions have been favorable, and with the experience of past years as a guide the several levees were surveyed, let to contractors, commenced, prosecuted, and completed without incident of considerable interest. I give in detail such information as will be of value.

Hardscrabble (641 R.).—New levee; length, 5,360 feet; height above natural surface, from 7.5 to 16.1 feet; grade, 3 feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on river side and 2½ and 4 to 1 on the land side; contents, 84,373.74 cubic yards. The embankment was built with the broken back or hollow slope on the land side made by giving the bank an inclination of 2½ to 1 for the first 5 feet below grade, and thence 4 to 1 to the natural surface. This levee was an extension down stream of the Hardscrabble levee of 1891–'92, and its construction was rendered necessary by the continued caving of the river bank in the Hardscrabble bend. The contractors commenced operations November 22, 1892, but prosecuted the work rather slowly during the favorable working season. The usual spring rains came on, labor became scarce, and when the contract date of completion March 1, 1892, arrived the embankment was only about half completed. Fortunately the front levee still held and the river did not rise to a dangerous height. The contract was extended to April 1, to April 15, and again to May 1, 1893. The levee was finally finished April 27, 1893.

Bondurant (643.5 R.).—New levee; length, 3,422 feet; height above natural surface, from 3.5 to 13.8 feet; grade, 3.7 feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 23,795.92 cubic yards.

In 1882–'83 the United States built a levee at this point, and almost every year since the rapid caving of the river bank has necessitated the construction of a new levee either by the General Government, State, or local authorities. During 1883 and 1884 the bank line receded 1,700 feet in eighteen months, the most rapid caving that I have ever heard of. The present levee is the last but one that it would be practicable to build between the Mississippi River and Lake Bruin. Work was commenced November 14, 1892, and the levee was completed December 30, 1892, forty-seven days in advance of contract time.

Grassmere to Wiccema (692 R.).—Enlargement work; length, 26,400 feet; height above natural surface, from 4.8 to 20.5 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on river side and 2½ to 1 on the land side; contents to date, 108,411.48 cubic yards. This levee is to be tile drained. Under the name of Grassmere to Wiccema was undertaken the first section of the general raising and enlargement of the United States Lake Concordia Levee, constructed in 1882–'83. The whole of the line around the lake, a distance of about 18 miles, has been a source of great expense for protection during high water, as it was low in grade and weak in section. Crevasses occurred in 1884, 1890, and 1891. The work done this season was recommended as far back as 1885. The contractors began work November 3, 1892, and completed embankment work April 10, 1893. The difficulty of securing tiles and their non-delivery until the river became too high to place them, has prevented the completion of this portion of the work. The delay necessitated repeated extensions of the contract time, and the work is not yet finished.

Wiccema to Fletcher (693 R.).—New and enlargement work; length, 23,071 feet; height above natural surface, from 5.1 to 30.5 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 131,169.17 cubic yards. This levee is tile drained and is the second section of the Lake Concordia enlargement. The stretch covers what has been termed the "bayou region," when all the crevasses of recent years have occurred. It is generally rather heavy work, as there are several dikes closing bayous, amongst others the Bayou Cocodrie. Construction was commenced November 18, 1892, and the levee, including the tile drains, completed April 24, 1893. The contract time was repeatedly extended, the last extension being to May 15, 1893.

Fletcher to Minorca (699 R.).—New and enlargement work; length, 18,423 feet; height above natural surface, from 5.6 to 16.7 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents to date, 119,837.68 cubic yards. Tile drains were to be used. This is the third section of the raising and enlarging of Lake Concordia levee. Contractors commenced work November 14, 1892, and the embankment was completed April 20, 1893. Fourteen hundred and forty linear feet of tiling has been laid, but on account of delay in delivery of tiles this portion of the work has not been completed. There remains on this levee a short piece of old embankment which was not raised or enlarged, as it is intended to replace it by a piece of entirely new levee 939 feet long. As was the case on other levees that were to be tile drained, the contract time had to be repeatedly extended on account of difficulty in obtaining tiles. The contract is still in force at date of report.

Minorca to Minors (702 R.).—New and enlargement work; length, 17,775 feet; height above natural surface, from 4.7 to 14.8 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents to date, 86,058.98 cubic yards; levee to be tile drained. This is the fourth and last section of the Lake Concordia enlargement. The length of the work as projected was 21,549 feet, but on account of scarcity of funds 3,774 feet of the old levee remains untouched.

Some of the untouched work is to be new levee, but the greater portion is enlargement. Work was commenced on November 14, 1892, and all of the embankment for which there were funds to pay for finished March 10, 1893. The laying of the tile drains was delayed by non-receipt of tiles, and this portion of the work is not completed. Sixteen hundred and twenty-six feet (linear) of tiling has been laid. The delay in receipt of additional tiles has necessitated the repeated extensions of the contract time, and the work is not yet completed.

Morrille (710 R.).—New levee; length, 5,200 feet; height above natural surface, from 3.8 to 9.7 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 28,592.52 cubic yards.

The old levee in front was on the immediate edge of the river bank and at one point had partly caved in. The bank is caving gradually and the destruction of the front line a question of but short time.

The contractors began operation on the new levee November 3, 1892, and completed it on December 9, 1893, sixty-eight days in advance of the contract time.

Fish Pond (725 R.).—New levee; length, 6,365 feet; height above natural surface, from 5.5 to 15.4 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 60,710.76 cubic yards. A rather unusual condition of affairs has developed at this locality. Here the United States has built several levees under different names, the first being in 1882–'83–'84, under the name of Greens to Fairview. A portion of this line was breached by caving banks in 1887, and a loop levee under the name of Deer Park had to be built in 1890–'91. This latter levee still holds, but at the time of its construction the funds were limited and the lower wing could not be carried as far downstream as would have been desired. After the subsidence of the flood of 1892 it was

considered that the caving of the river bank would breach this lower wing before the high water of 1893, and an extension 10,365 feet long of the curtain of the levee of 1890–'91 was surveyed and let under the name of Fish Pond Levee. There were some objections on the part of property owners as to the location of the line, which delayed matters so that it was not until February 14,1893, that the contractors commenced work. In the meanwhile the condition of affairs as regards the existing line had materially changed. The caving bank instead of breaching the lower wing of the Deer Park levee of 1890–'91 had eaten in with great rapidity toward the curtain or main portion of that levee, promising its early destruction from end to end. Under the circumstances all work on the upper 4,000 feet of the Fish Pond Levee was suspended, pending a change of line and extension upstream. This survey can not be made for final location until the subsidence of the high water of 1893 and the caving of the river bank recommences. Work on the remaining 6,365 feet of levee was pushed and it was completed April 28, 1893.

Repairs.—The repair work during the past season has been confined principally to two of the largest United States levees in the district—Hard Times (633 R.) and Gibsons Landing (683.5 R.), the former crossing the foot of Lake St. Joseph and the latter the foot of Lake St. John. It was desired to place the very large dikes crossing these lake beds in as nearly an absolutely secure condition as possible, for if they should be destroyed by a crevasse it would be almost impossible to rebuild them.

The work was done by hired labor. A force averaging about 60 men was organized and placed on the quarter boat *New Orleans* on November 22, 1892, and the repairs to the Gibsons Landing Levee (683.5 R.) were commenced. The levee was generally repaired where gullied by rain wash, but the major portion of the work was done on the dike crossing Lake St John. The length of the dike is about 1,700 feet with water on both sides. In consequence earth had to be hauled from either bank of the lake, which made the work slow and expensive. The dike was, however, thoroughly repaired and enlarged, the work being completed January 17, 1893.

The quarter boat and force were then transferred to Hard Times levee (633 R.), and work on the dike across Lake St. Joseph commenced. This dike has always given trouble on account of the embankment sinking into the soft lake bed. It had been repeatedly raised, but without proportionate enlargement of base, and the result was a narrow crown and hollow slopes. These defects were thoroughly repaired for a distance of about 1,000 feet, and as the sinking appears to have ceased the dike is now probably stronger than the levees in the vicinity. Here also the work was slow and expensive on account of the difficulty in obtaining earth, which had to be wheeled long distances. The repairs contemplated by the hired labor force were completed February 28, 1893, and the force discharged. The quarter boat was returned to Natchez and laid up in readiness for high-water protection work should it be necessary.

A portion of the Hardscrabble Levee (639 R.) of 1891-'92, had sloughed and settled below grade. It was a small affair and repaired by placing 382 cubic yards of earth on the low place, under an informal agreement. This levee work was done in March, 1893.

SURVEYS LOWER TENSAS LEVEE DISTRICT.

An unusually large amount of this sort of work has been done, and a survey party has been almost constantly in the field.

The work has been somewhat varied, consisting of the necessary surveys for current levee construction, surveys for work to be done under the allotment for 1893–'94, and preliminary surveys where existing levees were threatened by caving banks. Several extensive preliminary surveys or examinations were made in accordance with resolutions of the Commission, to obtain data as to condition of existing levees, cost of closing gaps, and practicability and cost of new levee behind Lake Bruin and St. Joseph should it become necessary to abandon existing front line, etc.

I give the work in detail, not in the order in which it was done, but from the upper limits of the district south, taking the right bank first:

At *Reid Levee* (605 R.) the existing line is seriously threatened by the caving of the river bank. A careful survey was made and 22,598 feet of new levee staked out. The old levee was traversed for 33,000 feet and about 6½ miles of bank line run.

The Commission had made an allotment of $5,000 towards the raising and enlarging of the levee on Davis Island (622 R.). Here the existing levee was traversed for 6 miles and leveled and cross-sectioned for 22,469 feet.

Hardtimes Levee (633 R.) the upper end of the old *Hardscrabble* (638.5 R.) and lower *Evergreen* (637.5 R.) were traversed, cross-sectioned, leveled for raising and enlargement for a distance of about 12,000 feet, and 9,000 feet of shore line was traversed.

The lower or new Hardscrabble Levee (641 R.) 5,360 feet long, was surveyed and staked out.

At *Bondurant* (642 R.) the old levee was traversed, leveled, and cross-sectioned preparatory to raising and enlarging for a length of 8,300 feet, and the new Bondurant Levee (643.5 R.), 3,422 feet long surveyed and staked out. A prospective extension of this line 5,630 feet long was also surveyed and staked out. The old levee was traversed for about 3 miles and 30,000 feet of bank line run.

A resolution of the Commission directed that a survey be made for a levee behind lake St. Joseph (632 R.) and Lake Bruin (643 R.). This survey was made and 98,896 feet of levee line located, leveled, and topography taken. Four miles of shore line in front of Lake Bruin was traversed.

It was thought that a new levee might be required at Cottage Home (649 R.). A reconnoissance of existing levee and bank line was made, from the results of which it was decided that a new levee was not required at present.

At *Upper Kempe* (657 R.) the caving of the river bank had recommenced and indicated that a prospective new levee would be required in the near future. The old levee was traversed for 20,000 feet and 3 miles of bank line ran. Preliminary survey of 22,000 feet of new levee line was made for estimating contents, cost, and best location for prospective new line.

The Gibson Landing Levee (683.5 R.) was traversed and leveled to determine settlement for 13,888 feet, and the dike crossing Lake St. John cross-sectioned for repair work for about 2,000 feet.

Rifle Point Levee (690 R.) was traversed, leveled, and cross-sectioned for a length of 16,974 feet.

The whole line of Lake Concordia Levee (692 R. to 702 R.) was surveyed, the total length of line being 93,711 feet. Of this 10,059 feet was new line to replace existing levee where too close to the lake bank, and the remaining 83,652 feet cross-sectioning of old levee for raising and enlargement. The levee being very irregular in shape, the field work was very tedious, requiring something over 1,100 cross-sections.

Between *Arnauldia* and *Moro* (702 R. to 709 R.) extensive surveys were made. Several alternative levee lines, aggregating 36,600 feet in length, were staked out. The old levee, for a distance of 46,000 feet, was traversed, and it was cross-sectioned for a length of 29,000 feet. Eight miles of bank line was meandered.

At *Morville* (710 R.) the new levee, 5,200 feet long, was surveyed and staked out and about 2 miles of shore line and old levee traversed.

The old levee from *Morville* (710 R.) to Greens (721 R.), a distance of 28,469 feet, was traversed and cross-sectioned for raising and enlarging.

Fish Pond Levee (723 R.), 10,365 feet long, was located and staked out and about 3 miles of bank line meandered.

Preliminary surveys of proposed levee lines were made between Fairview (728 R.) and Union Point (742 R.), including the Bougere Crevasse (739 R.). The length of line surveyed was 93,370 feet, and 6 miles of shore line was traversed.

This completes surveys in the lower Tensas Levee district, but other work was done on the left bank in what has been termed the

Big Black Levee district.—A resolution of the Commission directed that a survey be made from the bluff just below Warrenton Landing (606.7 L.) to Grand Gulf (636.2 L.), and from Rodney (652 L.) to Coles Creek (672 L.) to ascertain the condition of present levees and estimate the cost of restoration.

These surveys have been made. Between Warrenton and Grand Gulf 17 miles of levee was traversed and leveled, old levees were located and cross-sectioned, and preliminary locations for new levees were made. About 7 miles of shore line was run.

Between Rodney and Coles Creek 13¼ miles of line was traversed, leveled and crossed-sectioned; existing levees were located and preliminary lines for new levees run.

Sketch maps, profiles, and estimates of all field work were made by the survey party while in the field.

I summarize the work as follows:

	Miles.
New levees (lines located in detail)	18.8
Old levees cross-sectioned for enlargement	38.4
Old levees traversed for topography, etc	32.1
Shore or bank lines run for topography, etc	39.0
Preliminary surveys for levee lines	71.0
Total	199.3

SUMMARY.

To summarize results it can be stated that the general condition of the levees in the Lower Tensas Levee district has been greatly improved by the work done during the past season, and a long step made in the direction of a safe and reasonable

permanent line. There are yet long stretches of levee low in grade and weak in section that would be a source of anxiety during extreme floods. Caving banks threaten some portions of the line, and foreshadow the abandonment of many miles of existing effective levee, but all the defects are known and will probably be remedied.

The special features of levee construction tried during the past season appear to have been successful. The tile drains have done the work expected of them, and the land base of the levee kept dry and hard by the seepage water being carried off through the tiling. The omission of the muck ditch has resulted in economy of construction without any injury to the levees, and the broken back or flattening of the lower portion of the land slope in high levees, while not yet tested, will be of undoubted benefit to levees exposed for a long time to the strain of extreme high water.

The total length of effective levees in the Lower Tensas district is now 125 miles. Of this 55.7 miles are levees built by the United States, being 47 per cent of the whole in reference to the length.

The total estimated cubical contents of existing effective levee in the district is 7,000,000 cubic yards, of this 4,000,000 cubic yards is contained in the United States levees, being 57 per cent of the whole in reference to quantity.

As the United States levees are, generally, very heavy ones, crossing old lake beds and low, heavily timbered swamps, I estimate their present value at $1,000,000. They have cost more.

In the Lower Tensas district, during the past season, 5.3 miles of new levee has been built, and 15.4 miles of old levee extensively enlarged, a total of 20.7 miles of levee containing 642,950.25 cubic yards of earth.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The report of Assistant Engineer William J. Hardee, in local charge of the Atchafalaya, Pontchartrain, and Lafourche levee districts, is as follows:

BATON ROUGE, LA., *May 31, 1893.*

SIR: I have the honor to submit the following report for works under my local direction for the year ending May 31, 1893:

Between the mouth of Red River and New Orleans the flood of 1892 attained a maximum of 1.7 feet above the highest previously known flood.

At the close of the annual report that flood had practically subsided and the river was generally falling rapidly.

Right bank below Red River.—The levees on the right bank below Red River, though tested to their utmost capacity, were intact, all crevasses having been closed within a few days after their occurrence, but the lines were considerably washed and worn by the long strain put upon them.

Shortly after the river had returned to within its banks a careful inspection disclosed that the levees constructed by the United States had suffered but slight injury.

The Highland Extension (814.5 R.) and Mayflower-Union (835 R.) were wave-washed in places and the sod on the front slope, where covered by water, had failed to grow. These were the only levees requiring repair; all others were found in good condition.

Left bank below Red River.—The general line of levees on the left bank below Red River had suffered badly from the flood of 1892 and five crevasses existed, through which the water continued to flow until the water reached a low elevation. The United States levees, like those on the right bank, were carefully inspected and found to be in generally good condition. No material damage, necessitating repair, existed.

GENERAL METHODS.

Assignment.—On August 17, 1892, I was assigned to local direction in the Atchafalaya Section, extending on the right bank of the Mississippi River from the mouth of Red River to the north bank of Bayou Lafourche, a distance of 122 miles; the Lafourche Section, extending on the right bank of the Mississippi River from the south bank of Bayou Lafourche (Donaldsonville) to the city of New Orleans, a distance of 79 miles, and the Pontchartrain Section, extending on the left bank of the Mississippi River from the city of Baton Rouge to the city of New Orleans, a distance of 132 miles.

Surveys.—On August 24 and 25, 1892, the Board of U. S. Engineer Officers on the Building and Repair of Levees made an examination of the points suggested by the local authorities as requiring new levees.

In accordance with instructions received on August 17, 1892, two survey parties, stationed on the U. S. quarter boat *Alpha*, which was moved by the launch *Alaska*, were organized, and on September 6, 1892, commenced surveying and staking new levee lines designed to be built from the 1893 allotments and to have a net grade of 2½ feet above the flood of 1892, conforming to drawings and written instructions received from you. Their cross sections vary according to height. With a net fill of 15 feet or more, crown 8 feet, river slope 3 to 1, land slope 2½ to 1 for first 6 feet below grade, 4 to 1 for next 6 feet, and 6 feet to 1 for remaining height. This section is classed A in this report. With a net fill ranging from 10 to 15 feet, crown 8 feet, river slope 3 to 1, land slope 2½ to 1 for first 5 feet below grade, and 4 to 1 for remaining height. This section is classed B in this report.

With a net fill of less than 10 feet, crown 8 feet, river slope 3 to 1, land slope 2½ to 1. This section is classed C in this report.

As soon as surveys had been made to the extent of the 1893 allotment the same survey parties were moved to Picayuneville (795.5 R.), near the head of the Atchafalaya district, and commenced the location of levees to be built under 1894 allotment.

Tile drainage.—In general the tiles were laid parallel to the line of the levee, near its rear base. The mains were designed to discharge into the existing open plantation ditches, and suitable cross drains were laid from the mains under the public road to secure outlets into these ditches.

The tile drains were estimated to secure the best results at a depth of about 3 feet below the natural surface of the ground, for the reason that the soil near the surface of the ground is generally porous, susceptible of easy percolation, and admits of greater transpiration than the body of an embankment built and compacted by the travel of teams. Owing to the shallowness of the plantation ditches into which they are made to discharge, the majority of the drains were placed near the surface of the ground. Where placed within a less depth than 1.5 feet below the natural surface they were laid a few feet within or under the base of the levee, to secure for them a sufficient covering as a protection against crushing by passing heavily loaded vehicles. The success of the tile drains would, in my opinion, be better assured if the plantation open ditches were of greater depth, for then the tiles could be placed at a lower elevation and given more inclination.

Muck or base ditches.—The plan practiced up to within one year ago of indiscriminately and universally cutting muck or base diches was, as was done last season, discontinued, such ditches being required to be dug only in localities where the surrounding conditions suggested the existence of hidden substances likely to eventually impair the integrity of the levee, and which called for removal.

Supervision.—The method of supervision employed consisted of 3 traveling surveyors, 1 at $125 per month, 2 at $100 per month each, whose duty it was to visit the several levees as required and execute all instrumental work. An inspector was placed in local charge of one or more levees, according to their proximity and his ability to properly supervise the work. It was the duty of the inspector to see that the general specifications and detailed instructions governing the work were properly executed, and to keep a daily journal or record of the force employed and other transactions at his levee; also to submit weekly reports of same. These men were paid $60, $75, or $90 per month, according to the number and size of levees under supervision.

Inspection.—From time to time, as the boats were assigned to duty under my direction, the steamers *Newton* and *Ruby* and tug *Comstock* and launch *Alaska* were used for short periods in making inspections of levees.

ATCHAFALAYA SECTION.

Allotment and disposition.—An allotment of $155,000 was made for levee work in this district for the fiscal year ending June 30, 1893, and $152,000 for the fiscal year ending June 30, 1894.

In accordance with the instructions received from you, lines for new levee were surveyed and staked at Barroza (823 R.), Belair (828 R.), Hickey Upper (841 R.), Medora (825 R.), and Fortville Lower (855 R.), for construction under 1893 allotment.

Construction.—Work was started on all of the above soon after receipt of notice that contracts had been made, except on Hickey Lower, which was omitted for lack of funds.

Large forces were employed and the contractors were generally energetic in prosecuting their contracts. The weather was favorable throughout the winter, and

assisted materially in the accomplishment before high water season of the large amount of work undertaken and commenced so late in the season.

By the 1st of March the embankment at the majority of the levees was completed. All were completed by April 1. Much difficulty was experienced by the contractors in securing tiles for the drains.

Only a small supply was on hand at the factories tributary to this section. These were soon exhausted, and the factories promptly set to burning more. In the meantime quantities of refuse, consisting of under-burnt, over-burnt, and misshapen tiles, were sent or brought to the levees for placement by some of the factories, who endeavored to take advantage of the inexperience of the contractors. Such tiles, of course, were rejected, resulting in the delay attending the receipt of new shipments. The delay in reception and placement of tiles is responsible for the long lapse of contract time at most of the levees.

The contractors for the Hickey Upper Levee experimented with a mechanical device for constructing the embankment. While the principle appeared sound, the machine contained many defects and weaknesses, resulting in frequent breakdowns and consequent delays.

The contract for Hickey Upper Levee was annulled on January 23, 1893. A new but short levee was badly needed a short distance below Eliza (842 R.). It was awarded to W. J. Bently & Co. by circular letter proposal, and work was promptly started.

Muck or base ditch.—Of the 17,161 feet of levee built in this district 1,500 feet of muck ditch, measuring 4 feet at top, 2 feet at bottom, and 3 feet deep, was dug, being about 9 per cent of the total length of the line.

Surveys.—During November and December, 1892, and January and February 1893, surveys were made at the following places with a view of constructing such lines as might recommend themselves as necessary to be paid for under and to the extent of the 1894 allotment:

New Texas (786 R.), Picayuneville (795.5 R.), St. Francis Church (798 R.), Allendale (825 R.), Belle Vale (825.5 R.), Viola (827.5 R.), Missouri (840 R.), St. Delphine (840.5 R.), Medora Upper (851 R.), Rebecca (857 R.), Dunboyne Upper (865 R.), Belle Grove (870 R.), Celeste (872 R.), Mount Salem (872 R.), and Babin (879 R.).

Of the foregoing levees, St. Francis Church, Belle Vale, Missouri, Rebecca, Dunboyne Upper, Belle Grove, Celeste, Mount Salem, and Babin were placed under contract. Some of these works were commenced as early as March, 1893.

General effectiveness.—Depending on location (sometimes in bend, sometimes on a point, or again, owing to location, in reach), method of construction, and obstacles anticipated, which regulate the price of work, the tabular statement and summary does not furnish an accurate conception of the value and importance of the work executed respecting its relation to the levee system.

To better illustrate, it is further stated that, based on the lineal length of the river, the channel taken as the line of effectiveness, the 17,161 feet of embankment in this district represents 15,780 feet of actual protection. The lengths for individual levees will be found in a tabulated statement.

And, again, the general line of levee in this district on the basis of new grade and section is estimated to average 12 feet high. Taking the contents of embankment for that height as a basis, the 17,161 feet of embankment actually constructed represents 22,383 feet of levee if applied at other points where the average prevails.

Tile drains.—The minimum grade or inclination given tile drains in this district is 0.1 foot to the 100 feet. The longest line placed with the minimum grade is 1,132 feet; the shortest, 300 feet.

The maximum inclination is 0.3 foot to the 100 feet. The longest line placed on this grade is 368 feet; the shortest is 249 feet.

The average inclination or grade is 0.17 foot to the 100 feet.

Results of tile drains.—At the date of the closure of this report, May 31, the water is against all of the levees in this district under which tile drains have been placed.

An inspection of the tile drains disclosed that the discharge ends of the major portion of them had been choked with silt washed by rains from the embankments.

This was promptly corrected and the tiles cleared of all obstructions.

The drains are running freely everywhere, keeping the back slope of the embankment and the ground in the rear perfectly dry, indicating clearly the practicability and usefulness of such system of drainage.

At those levees where no tiles were laid the seepage is free and the base ditches at the foot of the land slope have been dug to effect the removal of the seepage which was saturating the embankment.

Repairs.—The experience of previous years has shown the value of proper drainage of borrow pits, that no water may stand in them when the river returns to within its banks.

A large amount of standing water thrusts just so much additional weight upon the bank, keeps the bank saturated, and tends to aggravate caving. This standing water

Lower (883 L.), Burnside (891 L.), Union Upper (893 L.), Union Lower (893 L.), Tippecanoe (894 L.), Peytavin (894.5 L.), Whitehall (895 L.), Tessier (909.5 L.), Hope (916.5 L.), Anchor (928.5 L.), and Trudeau (949 L.).

Construction.—Work was started on all of the above soon after receipt of notice that contracts had been made except on Anchor, which it was considered advisable to omit, and which accordingly was not advertised.

A balance remains unapplied. At later dates contracts were made for the construction of levees at Lopez (844.5 L.), Jolisant (858 L.), Towles (851 L.), and Billings (852.3 L).

Large forces were employed everywhere but at Trudeau, and the contractors were generally energetic in the prosecution of their contracts. Favorable weather was experienced and by March 10, 1893, all embankment was completed.

As in the other districts, much difficulty was experienced in securing acceptable tiles, and to the delay in their receipt must be credited the extended dates on which levees were fully completed.

Several shipments of inferior tiles were received at levees in this district and were rejected as a whole.

During the last week in January, P. J. Coffman, the contractor for Trudeau Levee, disappeared and inquiry failed to determine his whereabouts.

But a small force was employed and the work was far behind. Repeated notifications, calling for additional force, had no effect. The contract was to expire on February 15, 1893. As that date approached the river was rising rapidly and it was a question if the levee could be completed before the river left its banks. The new and existing levee lines are too close together to admit of sufficient building material being obtained during the wet season between the two. The anticipated breach of the existing levee had not occurred; the banks were in good condition and examination of them justified the opinion that it would be wiser to let the completion of the levee remain over until the succeeding season than to use the existing levee, which would have to be done, and in the face of a rising river. The Trudeau contract was therefore allowed to expire by limitation. No extension was granted and when operations were suspended the levee was between 35 per cent and 40 per cent completed.

Muck or base ditches.—On the 45,452 feet of levee built in this district 1,100 feet of muck or base ditch, measuring 4 feet on top, 2 feet on bottom and 3 feet deep, was dug, being about 4 per cent of the total length of the lines.

Surveys.—During November and December, 1892, and January, February, and March, 1893, surveys were made at the following places with a view of constructing such lines as might be considered necessary, to be paid for from the 1894 allotment:

Shannon Lower (837 L.), Conrad (840 L.), Ben Hur (846 L.), Towles to Billings (851.5 L.), Plaquemine Point (854 L.), Lorio (867 L.), Point Clear (867.5 L.), Maryland (827 L.), Rescue (847 L.), Southwood Upper (847.7 L.), Belle Helene (879 L.), Houmas (890.05 L.), Hester (908.5 L.), St. Elmo (910 L.), Poche (911 L.), Angeline (915 L.), Terre Haute (921 L.), and Prospect (936 L.).

Of the foregoing levees, Shannon Lower, Maryland, Rescue, Southwood Upper, Belle Helene, Houmas, Hester, St. Elmo, Poche, Terre Haute, and Prospect were placed under contract.

Some of these works were commenced as early as February, 1893.

General effectiveness.—The 45,452 feet of levee built in this district represents 48,436 feet of actual protection, the channel of the river taken as the line of effectiveness. The lengths for individual levees will be found in tabulated statement.

The general line of the levees in this district is estimated to average 10 feet high. If applied at points where the average prevails, the 45,452 linear feet of levee constructed would represent 48,000 linear feet.

Tile drains.—The minimum grade or inclination given tile drains in this district is 0.1 foot to the 100 feet. The longest line placed with the minimum grade is 1,570 feet; the shortest is 325 feet.

The maximum inclination is 0.6 foot to the 100 feet. The longest line placed with this grade is 390 feet. The shortest, 390 feet.

The average inclination of grade is 0.22 foot to the 100 feet.

Results of tile drains.—The same thing is to be said relative to observations and results of tile drains in this district as is reported for the Atchafalaya and Lafourche districts.

Drainage.—As in the two preceding levee districts, the same care was exercised to secure proper drainage of borrow pits.

Repairs.—The levees previously built by the United States in this district were generally in good condition and required no extensive repairs. Owing to difference of the method of construction of the several portions of the levee, about 1,800 feet of the Woodstock (847.5 L.) levee and all of the Union (893 L.) and Irvine (894.2 L.) levees had settled unevenly both on top and sides.

These levees were raised about 1.5 feet, and the slopes correspondingly filled out to bring the whole to a uniform grade and section; the work being executed by a force employed under open-market agreement, that being the most advantageous method of doing the work.

Drainage ditches for the removal of water from the borrow pits at Woodstock (847.5 L.) levee were dug by hired labor.

At the Trudeau levee, abandoned by Contractor Coffman, a drainage ditch had been cut along the inside base of the existing levee to secure drainage into the river. The two outlet ditches were refilled by the agents of the contractor who had cut them. On March 8, during a storm, one of them washed out and occasioned a small crevasse. I was notified almost immediately, went to the locality with lumber and sacks and in a few hours had the water shut off and the place made secure.

It was considered that the drainage ditch in the rear of the existing levee had weakened it and trouble would be occasioned by it in the event of a high stage of river. Consequently the U. S. quarter boat *Delta*, with a force averaging 50 men, was sent to the Trudeau levee and employed from March 28, 1893, to April 6, 1893, in draining the ditch, refilling and tamping it, which fully restored the integrity of the levee as far as it had been impaired.

ABANDONMENT AND CONDITION.—During the year all of Bourgeois Section (910 L.) and portions of the Woodstock (847.5 L.), Hermitage (850 L.), Southwood (875.5 L.), Dicharry (882 L.), Union (893 L.), Irvine (894.2 L.), and Tessier Section (969.5 L.) were abandoned by construction of new levees. At the close of the year ending May 31, 1893, there were 133,030 feet of existing effective levee built in whole or in part by the United States in this district.

STATE AND DISTRICT BOARD WORK.—During the year the following work was executed by the local authorities:

By the Pontchartrain Basin Levee Board: New levee, 3.57 miles, 448,810 cubic yards, costing $125,644.82; enlargement, 20.12 miles, 276,075 cubic yards, costing $64,388.08; total 23.69 miles, 724,885 cubic yards, costing $190,032.90. A large amount of repairs, consisting of cutting out crayfish holes and leaks, restoring wavewash, and strengthening wooden revetment, was done at a cost of $38,626.87.

By State authorities: New levees, 1.55 miles, 76,345 cubic yards, costing $9,008.71; enlargement, 3.01 miles, 69,785 cubic yards, costing $8,234.63; total, 4.56 miles, 146,130 cubic yards, costing $17,243.34.

Protection.—At the close of this report, May 31, the river lacks an average of about 2.5 feet of being as high as the water of 1892.

The same preliminary steps for protection service have been taken in this district as are defined in report for Atchafalaya District.

The local authorities are also organized and working in the same manner as described in that report.

Simmesport Levee (under the appropriation for improving Red and Atchafalaya rivers).—It was considered advisable to repair and strengthen this levee, and $800 was allotted for the purpose to cover the cost of work, supervision, incidentals, etc. Circular letter proposals were invited, and the contract awarded to E. W. Hanlon & Co.

An inspector who could run levels and measure the work in progress as well as otherwise supervise the repairs was stationed at the levees in local charge.

Work was commenced on January 4, 1893. Only a small force was operated, and work was commenced on February 18, 1893.

The work consisted of cutting out and refilling all leaks. Where there was a succession of leaks forming a continuous line or chain, the entire levee was cut away and a ditch of 5 feet deep sunk through the natural ground to cut and close up all leaks beneath the surface. The embankment was rebuilt to a grade of 2½ feet higher than the 1892 water, 6-foot crown, river slope 3 to 1 and land slope of 2½ to 1. This made the section of the levee so rectified approximately three times larger than it previously was.

Of the 1,300 feet of levee, 438 feet were rectified, embracing 3,669.89 cubic yards, which was all that could be accomplished with funds available.

Very respectfully, your obedient servant,

W. J. HARDEE,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

REPORT OF SURVEYOR JOHN SMYTH, JR., IN LOCAL CHARGE OF THE LAKE BORGNE AND BARATARIA LEVEE DISTRICTS.

NEW ORLEANS, LA., *May 31, 1893.*

SIR: I have the honor to submit the following report on the surveys, construction and repair of levees, Barataria and Lake Borgne levee districts, for the year ending May 31, 1893.

Assistant Engineer W. G. Price was in local charge of these districts until February 17, when he was granted leave of absence.

I was assigned to duty as surveyor in these districts on December 8, 1892, and on February 17 I was directed to take local charge, relieving Mr. Price.

June 1, 1892, no work had been done in these districts by the United States.

SURVEYS AND INSPECTIONS.

The board of district officers on building and repairing levees, Mississippi River, accompanied by the chief of Louisiana Board of State Engineers, passed through these districts on the U. S. steamer *Titan* between August 26 and August 28, 1892, making personal examination of localities where it was proposed to apply the allotted funds.

On September 2, 1892, Assistant Engineer W. G. Price and Surveyor A. F. Woolley, jr., reported at New Orleans, La., for duty in these districts, and commenced inspection of existing levees. Mr. Woolley was transferred to other works on December 8, 1893.

On September 26, 1892, a decked barge from the New Orleans Harbor was transferred to these districts and fitted up as temporary quarter boat for use of survey party then engaged in staking out lines for proposed new levees. This quarter boat was kept in service until January 23, 1893, when it was returned to New Orleans Harbor, and survey party was reduced to one surveyor and one rodman with Assistant Engineer Price in local charge.

Lines were staked out for the following proposed levees, new and enlargement: Slaughter House (968.5 L.), Bonzano (969 L.), Chalmette Cemetery (969.5 L.), Deboushel (970 L.), Pecan Grove (973 L.), Story Upper (974 L.), Story Lower (975 L.), Repose (976 L.), Cærnarvon (979 L.), Orange Grove Upper (980 L.), Orange Grove Lower (980 L.), Magnolia (980.5 R.), Fort St. Leon Upper (981.5 R.), Fort St. Leon Lower (982.5 R.), Belle Chasse (983 R.), Belle Chasse Crevasse (984 R.), Belle Chasse to Concession (985 R.), Concord (987 R.), Oak Point (988.5 R.), Oakville (990.5 R.), Live Oak (991.5 R.), Happy Point (994 R.), Star (998 R.), Ironton (1,002.5 R.), Oakland (1,006 R.).

Preliminary surveys were made for the following levees to be built with funds for the fiscal year ending June 30, 1894: Battle Ground (969.5 L.), Irving (976 L.), Orange Grove (979 L.), English Turn (982 L.), St. Clair (983 L.), Mon Plaisir (984 L.), Magnolia (980.5 R.), Kearney (983 R.), St. Anne (984.5 R.), Deboushel Dobard (992 R.).

BARATARIA DISTRICT—CONSTRUCTION.

Magnolia Levee (980.5 R.).—This consists of two pieces of enlargement. Upper section 4,570 feet long and lower section 1,000 feet long. There is a line of old levee 2,100 feet long between these sections which it was contemplated to enlarge but owing to lack of funds and tendency of river bank to cave along this line, work was abandoned, nothing having been done except clearing.

One thousand nine hundred and five and two-thirds linear yards of 6-inch porous tiles were put in toe of land slope where levee was enlarged. Maximum depth of tiles below surface of ground is 4.9 feet, minimum 2 feet, mean 2.4 feet; maximum slope per 100 feet 0.40 foot, minimum 0.10 foot, mean 0.15 foot. These drains have outlets as follows: At Station 4, double; at 19 plus 90, double; 23 plus 92, single; 35 plus 50, double; 39 plus 90, 66 plus 10, double.

Four thousand two hundred and thirty-nine linear feet of revetment, in accordance with plan hereafter described, was built on new slope of levee as follows: From Station 5 plus 11 to 21 plus 22, 1,528 feet; 25 plus 67 to 42 plus 9, 2,024 feet; 62 plus 91 to 69 plus 72, 686 feet. This revetment is still in good condition, though the 4 to 1 slope of embankment has been washed in places by waves from passing steamers.

Fort St. Leon Upper (981.5 R.).—This is a new line. The old levee abandoned by this line is of low grade and inferior section.

Six hundred and twenty-eight and two-third linear yards of 6-inch porous tiles were put in toe of land slope. Maximum depth 2.7 feet, minimum 1.4 feet, mean 2; maximum slope per 100 feet 0.2 foot, minimum 0.1 foot, mean 1.7. This drain has three double outlets, one at 2 plus 97, one at 9 plus 48, and one at 15 plus 40.

Revetment was not built on this levee as embankment is protected from serious wash by willows and high batture.

Fort St. Leon Lower (982.5 R.).—This is a new levee built back of an old and insufficient embankment which was too near the river bank to justify the enlargement. Two hundred and eighty-five and one-third linear yards of tile drains were put in the toe of the land slope. Maximum depth 3 feet, minimum 2 feet, mean 2.5 feet; mean slope per 100 feet 0.1 foot. Outlets as follows: One at 2 plus 50 single, one at 5 plus 40 double. Revetment omitted for similar reason as at Fort St. Leon Upper.

Belle Chasse Crevasse (983 R.).—This levee consists of 650 feet of enlargement above and below bank, and 92 feet of new levee across opening. It was built on original line of old levee to close crevasse of 1892.

Two hundred and seventy-one linear yards of tiles drains, 6-inch porous, were put in toe of land slope; maximum depth 2.5 feet, minimum 2 feet, mean 2.1; maximum slope .20 foot, minimum .10 foot, mean 0.18 foot. This drain has two single outlets, one at 203 and one at 208 plus 65.

Levee is protected from wave wash by dense growth of willows and batture revetment was therefore omitted.

Belle Chasse to Concession (985 R.).—This consists of three sections. Upper line is a new section 641 feet long, built back of an old embankment which is immediately on river bank. Openings were made in old levee to drain borrow pits into river. No embankment built on this section as new is protected by old levee. Middle section is 4,918 feet of enlargement and 416 feet of new levee. Lower section is 3,700 feet of enlargement. Owing to difficulty in procuring earth on account of baggase on batture in front of Belle Chasse Sugar House, extension of time of completion was granted. Old levee was cut down prior to enlargement, in both middle and lower sections.

Thirty-four hundred and four and two-thirds linear yards of 6-inch porous tiles were put in toe of land slope; maximum depth 4 feet, minimum 1.8 feet, mean 2 feet; maximum slope per 100 feet 0.20 foot, minimum 0.10 foot, mean 0.20 foot. These drains have outlets as follows: Upper section, one double outlet at 2 plus 80; middle section, one single outlet at 273 plus 40, one double outlet at 275 plus 80, one single outlet at 280 plus 90, one double outlet at 285 plus 70, one single outlet at 3 plus 80, one double outlet at 0 plus 40, one double outlet at 2 plus 80, one double outlet at 18 plus 50, one double outlet at 25 plus 90, one double outlet at 34 plus 60; lower section, one double outlet at 67 plus 60, one single outlet at 69, one single outlet at 74, one single outlet at 89, one single outlet at 94.

Eight thousand one hundred and seventy-four linear feet of revetment was built on river slope of levees as follows: from 269 plus 50 to 37, 5,280 feet; from 65 to 92, 2,894 feet. This revetment is in good condition though the 4 to 1 slope of the embankment has been washed in many places and slight wash has occurred on embankment inside of revetment between stations 30 and 31. The lumber used in constructing the revetment was green and since drying there are places of about three-eighths inch between planks, through which water ebbs and flows. The height of revetment is about 4 feet, top being about even with net grade of embankment.

Concord Levee (987 R.).—This is a new levee built back of an old and insufficient embankment which was raised with mud box to withstand high water of 1892, and was so near river bank as to justify enlargement. Owing to bad weather and accumulation of sipe water in borrow pits extension of contract time for completion was recommended.

Old front levee is still intact, but as there are many crayfish holes through it the water in borrow pits has, since completion of new line, assumed level of that in the river.

This work was commenced with small force, on December 23, 1892, but owing to bad weather it was abandoned after little had been done. Work was not resumed until February 1, 1893, when the river had risen to within 1 to 2 feet of surface of batture, making the obtaining of earth therefrom very difficult.

On March 4, 1893, U. S. quarterboat *Delta* with force of 55 wheelbarrows was put on this levee to insure completion before usual flood season. This force, together with that of the contractor, was employed in embankment construction until March 25, 1893, when quarterboat was needed on delinquent work above New Orleans.

Embankment here being within 1 to 1½ feet of gross grade and old levee still intact, all was considered safe and quarterboat with the force thereon was moved elsewhere. Levee was finally completed on April 21, 1893.

Nine hundred and forty-three and two-thirds linear yards of 6-inch tile drains (porous tiles) were put in toe of land slope; maximum depth 3.6 feet, minimum 2.0 feet, mean 2.8 feet; maximum slope per 100 feet 0.20 feet, minimum 0.10 feet, mean 0.14 feet. This drain has five double outlets as follows: At 2 plus 70, 6 plus 30, 14 plus 60, 19 plus 60, 23 plus 70; new levee protected by old; revetment omitted.

Oak Point Levee (988.5 R.).—This is a new levee built back of an old one which was too near the river bank to justify enlargement. Embankment was completed within

contract time, but extension was granted until March 10, 1893, as tile factory was unable to furnish tiles owing to a freeze during January, 1893, having caused the loss of two kilns of tiles while drying.

Seven hundred and eighty-six and two-thirds linear yards of porous tiles, sizes 5-inch, 6-inch, and 7-inch, were put in a toe of land slope, the size of tiles increased as they neared the outlets; maximum depth 2.6 feet, minimum 2 feet, mean 2.2 feet; maximum slope per 100 feet 0.40 foot, minimum 0.10 foot, mean .12 foot. This drain has three double outlets. One at 3 plus 83, one at 13 plus 44, and one at 20 plus 82. This is the only place in the district at which tiles of different sizes were used, and while all tiles put in at other levees seem to be draining very well, I am led to believe that there may be some advantage in increasing size of tiles toward outlet, especially in the case of a long drain with few outlets. New levee is protected by old one. Revetment omitted.

Live Oak Levee (991.5 R.).—This consists of two sections. Upper section is enlargement 400 feet long, and being only preparatory work the old line was not cut down.

Lower section is new levee 844 feet long, built back of an old and insufficient embankment which was too near river bank to justify enlargement. There is a stretch of 830 feet of old levee between these sections which is of moderately good section and height, and has been revetted lately by the local district levee board.

Three hundred and twenty-six and two-thirds linear yards of 6-inch porous tiles were put in toe of land slope of lower section; maximum depth 2.7 feet, minimum 1.9 feet, mean 2.1 feet; maximum slope per 100 feet 0.20 foot, minimum 0.10 foot, mean 0.11 foot. This drain has one outlet at 7 plus 40.

Eight hundred and thirty eight linear feet of revetment was built along the river slope from 0 to 8 plus 44, entire length of lower section. Upper section is protected from serious injury by high batture.

Happy Point Levee (991).—This consists of 414 feet of enlargement and 1,396 feet of new levee, continuous line. Portion of old levee abandoned was used in the construction of the new line.

Five hundred linear yards of 6-inch porous tiles were put in toe of land slope; maximum depth 3.1 feet, minimum 2 feet, mean 2.1 feet; maximum slope per 100 feet 0.20 foot, minimum 0.10 foot, mean 0.14 foot. This drain has two outlets, double, one at 8 and one at 11. Revetment omitted, high batture in front.

LAKE BORGNE LEVEE DISTRICT—CONSTRUCTION.

Slaughter-house Levee (968.5 L.).—This is enlargement built on line of old levee after the same had been cut down.

Two hundred and thirty and thirty-three one-hundredths linear yards of 6-inch porous tiles were put in toe of land slope to carry off the sipe water. Maximum depth of tiles below surface of ground is 3.7 feet, minimum 1.4 feet, mean 2 feet. Mean slope of drain per 100 feet is 0.15 foot. This drain has but one outlet, which is at the lower end of the line.

Seven hundred and sixteen linear feet of revetment was built on river slope of levee from 0 plus 7 to 0 to 7 plus 16. This revetment is in good condition, although the 4 to 1 slope (of levee) outside of revetment has been washed away.

Roy Levee (969 L.).—This is a new levee, built immediately back of an old and insufficient embankment. Old levee was used in construction of new. The new levee runs along the original line of Chalmette Cemetery shell road, and much time was consumed in removing shells, which necessitated extension of contract time for completion. However, after shells were removed work progressed favorably.

Three hundred and eighty-seven linear yards of 6-inch tiles were put in toe of land slope; maximum depth 3.0 feet, minimum 2 feet, mean 2.2 feet; mean slope per 100 feet 0.10 foot. This drain has one double outlet at 0 plus 50, near upper end of line.

Eleven hundred and forty-three linear feet of revetment was built on river slope from 0 to 11 plus 39. This revetment is in good condition, excepting at 0 plus 20, where two 12-inch planks in facing have been washed loose at foot. The top of this revetment is about 6 feet below net grade of embankment. It was so constructed that the posts and facing might find good footing in solid ground. Notwithstanding this, the above-mentioned slight damage has been done, principally by waves from passing steamers, and the 4 to 1 slope on the river side of revetment has been washed away along the entire line.

Bonzano Levee (969 L.).—This is a new levee and, like Roy, was built back of an old one. It crosses Chalmette Cemetery shell road in two places, but removal of shells did not cause much delay in progress of work. Old levee was used in construction of new.

Three hundred and twenty-seven linear yards of 6-inch porous tiles were put in toe of land slope; maximum depth 2.2 feet, minimum 2 feet, mean 2.1 feet; mean

slope per 100 feet 0.10 foot. This drain has one double outlet 96 feet from upper end of line.

Six hundred and eighty-two and one-half linear feet of revetment was built on river slope from 0 to 6 plus 83. This revetment is in good condition, though the 4 to 1 slope of levee has been washed badly in places.

Chalmette Cemetery Levee (969.5 L.).—This consists of 300 feet of enlargement and 582 feet of new levee. Old levee was used in construction of new.

Two hundred and ninety-four linear yards of 6-inch porous tiles were put in toe of land slope; maximum depth 3.1 feet, minimum 1.8 feet, mean 2 feet; maximum slope 0.20 foot, minimum 0.10 foot, mean 0.12 foot. This drain has two double outlets, one at 2 plus 60 and one at 6 plus 75.

Eight hundred and seventy-seven linear feet of revetment was built on river slope, from 0 to 8 plus 82. This revetment is in good condition, and owing to the high batture in front little damage has been done to the 4 to 1 slope. Top of revetment is about level with net grade of embankment.

Debouchel Levee (970 L.).—This is a new levee, built immediately back of an old embankment, 125 feet of which had caved into the river. Remaining portion was used in the construction of new work.

Two hundred and fifty-one and sixty-six one-hundredths linear yards of 6-inch porous tiles were put in toe of land slope, of maximum depth 2.5 feet; minimum, 2 feet; mean, 2.2 feet. Maximum slope per 100 feet is 0.20 feet; minimum, 0.10 feet; mean, 0.14. This drain has two double outlets, one at 0 plus 63 and one at 5 plus 66.

Six hundred and seventy-eight and seventy-five one-hundredths linear feet of revetment was built on river slope from 0 to 6 plus 98. This revetment is in very good condition, although the 4 to 1 slope of embankment has been washed away. The top of this revetment is about 0.8 feet below grade of embankment, and stood originally about 3.2 feet above ground. Now in many places as much as 6 feet of facing stands above ground on the river side.

Pecan Grove Levee (973 L.).—This consists of 730 feet of enlargement and 732 feet of new levee. Old levee was used in construction of new. This levee is protected by high batture and willows; revetment omitted.

Story Upper Levee (974 L.).—This is enlargement of an old levee after the same had been cut down; protected by willows, high batture, and remains of an old levee in front; revetment omitted.

Story Lower Levee (975 L.).—This consists of 3,498 feet of enlargement and 1,185 feet of new levee. Old levee abandoned by new was used in construction. When enlarged it was cut down prior to placing of new earth. This levee, like Story Upper, is protected from serious wave wash; revetment omitted.

Repose Levee (976 L.).—This is a new levee, built back of an old embankment which was too near the river bank to justify enlargement. Old levee was used in the construction of the new. This levee is partially protected from wave wash by high batture at upper end of line. It should, however, have been revetted but for lack of funds.

Orange Grove Upper Levee (980 L.).—This is a new levee, built back of an old and insufficient embankment which was raised with mud box to withstand the high water of 1892, and too near the river bank to justify enlargement. Old levee is still standing, but, owing to its being practically honeycombed by crayfish, serves only to prevent wave wash of new embankment; revetment omitted.

Orange Grove Lower Levee (980 L.).—This is a new levee, built back of an old embankment which was immediately on the river bank. Openings were made in the old levee to drain borrow pits into river. Old levee still standing; revetments omitted.

REPAIRS.

Slaughter-house extension (968.5 L.).—Raising and enlarging levee 1,826 feet long; average net fill 1.5 feet. Crown is now 8 to 10 feet wide; slopes approximate 2½ to 3 to 1. Approximate amount of earth placed on this levee is 3,037 cubic yards. Cost to United States, including 784 linear feet temporary revetment and 1,381 linear feet of 3-wire fence, $1,171.64. This work was done by force on the U. S. quarter boat *Delta*. The wire fence was built along toe of land slope to protect levee from being injured by cattle going to and from stock landing.

Where revetment was built the following plan was adopted: The facing was made of planks 8 feet long, 1¼ inches thick, and not more than 12, nor less than 6 inches wide. These were nailed to two rails 2 inches by 6 inches by 18 feet, one flush with and one 4 feet below top of facing. The rails were firmly nailed to 3-inch by 4-inch by 9-foot posts driven 9 feet apart in river slope of levee at a point 12 feet from center line of embankment. These posts have each one brace 2 inches by 6 inches by 13 feet, which extends 6 inches over top rail of revetment facing and notched to fit down over top rail, thereby giving more strength to resist pressure from river side. The braces were nailed to posts, the upper edge of brace being about flush

with top of post. The other end of brace was nailed to stakes driven (one 2 by 6 inches by 3 feet) in center of crown on opposite sides of brace. There was another stake driven 1 foot to land side of center of crown and against end of brace, as a butting stake, in order that any jar received by revetment facing from floating logs, etc., might not be thrown entirely upon nails in the two stakes before mentioned. After facing posts and braces had been securely fixed in place an additional rail, 2 by 6 inches by 18 feet, was nailed on outside of and flush with top of facing to prevent planks forming the same being easily removed.

Nails used in securing braces to posts and stakes and rails to posts were 50-penny wire nails; those used in securing facing to rails were 16-penny wire nails. Lumber used was sound cypress, free from shakes or loose knots.

Plan of construction.—A trench was dug in river slope of levee 12 feet from center line, about 1 foot wide and 2½ feet deep. The side of trench against which revetment was to rest was made straight and of proper slope, *i. e.*, 1 foot to 8 feet. Posts were placed in trench and driven 2 feet into earth which had not been disturbed. After nailing on the two rails the boards for facing were driven about 1½ feet below bottom of trench; braces, etc., were fixed in place, and trench filled with earth thoroughly tamped.

No batting was used on seams in facing, planks having been leveled at point and driven closely.

When embankment was over 7.5 feet net height revetment was lowered in order that facing might be driven into original earth. This proved successful, for in many cases the 4 to 1 slope has been entirely washed away.

LEVEES 1893–'94, BARATARIA LEVEE DISTRICT.

Magnolia Levee (*980.5 R.*).—This consists of two sections. Upper section is to be a new levee, approximately 2,130 feet long, connecting Magnolia Upper and Lower levees of 1892–'93.

Lower section is to be enlargement, approximately 636 feet long, connecting Magnolia Lower and Fort St. Leon Upper leevees of 1892–'93.

Fort St. Leon Middle (*982 R.*).—This as originally intended was 3,300 feet of enlargement, connecting Fort St. Leon Upper and Lower levees of 1892–'93.

Kearney Levee (*983.5 R.*).—This is to be a new levee approximately 2,010 feet long.

St. Anne Levee (*984.5 R.*).—This is to be enlargement, approximately 2,000 feet long. It will connect middle and lower sections of Bello Chasse to Concession Levee of 1892–'93.

Belle Chasse (*983 R.*).—This is to be a new levee approximately 5,462 feet long.

Oakville Levee (*990.5 R.*).—As originally surveyed, this consists of 3,493 feet of new levee line and 1,500 feet of enlargement, making a total of 4,993 feet.

Dobard Levee (*992 R.*).—This is to be a new levee 2,896 feet long.

Star Levee (*998 R.*).—This is to be enlargement 5,568 feet long.

Ironton Levee (*1002.5 R.*).—This is to be enlargement, approximately 2,840 feet long.

Oakland Levee (*1006 R.*).—This as now contemplated will be two pieces of enlargement, one 1,050 feet long and one 1,840 feet long, separated by 200 feet of old levee which is of good section and moderately good height. Total length of line, 2,890 feet.

LEVEES 1893–'94, LAKE BORGNE LEVEE DISTRICT.

Battle Ground Levee (*969.5 L.*).—This as now contemplated will consist of four sections as follows: Enlargement, approximately 415 feet long, connecting Roy and Bonzano Levees of 1892–'93. Enlargement, approximately 340 feet long and new levee approximately 1,000 feet long, connecting Bonzano and Chalmette Cemetery levees of 1892–'93. New levee, approximately 332 feet long, connecting Chalmette Cemetery and Deboushel levees of 1892–'93. New levee, approximately 1,650 feet long, and enlargement, approximately 1,489 feet long, running from lower end of Deboushel Levee of 1892–'93 down to Sugar House Point.

Irving Levee (*976 L.*).—This will consist of approximately 4,625 feet of new levee and 800 feet of enlargement. This levee runs from lower end of Story Lower Levee of 1892–'93 down to Lake Borgne Canal. Work was commenced on lower portion of this levee on April 12, 1893, with small force and has progressed favorably. About 20,000 cubic yards of earth has been put in place.

Cacrnarvon Levee (*979 L.*).—This is to be a new levee 2,100 feet long.

Orange Grove Levee (*980.5 L.*).—This consists of two pieces of new levee, one 1,200 feet long, connecting Orange Grove Upper and Lower levees of 1892–'93, and one 703 feet long connecting Orange Grove Lower Levee of 1892–'93 with large State levee just below.

English Turn Levee (*982 L.*).—This is a new levee 2,660 feet long.

Work was commenced on this levee April 17, 1893, and finally completed May 29, 1893.

St. Clair Levee (983 L.).—This levee as staked out is a new levee 7,332 feet long, 6,219 feet on batture and 1,113 feet back of existing levee.

Mon Plaisir Levee (984 L.).—This is to be a new levee 2,780 feet long.

HIGH-WATER PROTECTION.

At date of this report the river reached a stage of 16.1 feet at New Orleans, 1.5 feet below highest previous record.

BARATARIA LEVEE DISTRICT.

Defects in levees so far developed are as follows:

Magnolia Levee (980.5 R.).—Some sipage through levee near upper end of line caused by defective plantation drain ditches into which tiles along toe of slope empty. There is a supposed crayfish leak in lower section of this levee, and as it seemed to be washing, work was commenced May 30, 1893, and flow of water stopped May 31, 1893, cost of labor being $49. Large leak in old line just above here was stopped, cost of labor being $18.50.

Belle Chasse Crevasse Levee (983 R.).—There is a crayfish leak at about Station 208 plus 40, discharge was clear though strong. Some earth was put in on river side of levee by planters, and flow of water has been lessened.

At a point about 1,000 feet below the Belle Chasse Crevasse Levee there are a number of crayfish holes. Loose earth was put in on river side, and crib built on land side and filled with earth. This was done by plantation owner, and result is satisfactory at present stage of the river.

Belle Chasse to Concession Levee (985 R.).—Slight wave wash on upper section, and at a few points in middle and lower sections there is slight wash inside of revetment.

There are numerous crayfish leaks in State and district levees from Concession plantation down to end of lower line. The worst place is about 400 feet above Junior, Plaquemines Parish, in State levee. The embankment is small and very much softened by water. Some work has been done by planters in the vicinity but have not visited the levee since.

Disposition made for protection work.—The U. S. tug *Tilda* was assigned for use in this district during high water. A large decked barge from New Orleans Harbor, loaded with lumber and sacks, was on May 20 towed by tug *Tilda* to Story Lower Levee (974 L.) in the Lake Borgne Levee district, and will be used whenever necessary.

Four hundred sacks had been previously distributed at various points in the district and on May 30, 1893, took one thousand sacks with wheelbarrows and shovels from New Orleans Harbor for use at Magnolia Levee (980.5 R.).

Local boards have inspectors along entire line and cars loaded with lumber and sacks stationed at different points throughout the district.

HIGH-WATER PROTECTION, LAKE BORGNE LEVEE DISTRICT.

Defects in levees so far developed are as follows:

Slaughter-house Levee Extension (968.5 L.).—Wave wash from passing steamers has damaged the temporary revetment, and in consequence the levee has been badly washed in several places. However, sacks of earth were placed wherever washed seriously, and there seems no longer any danger at present stage of the river. This work was done by citizens in the vicinity.

Roy Levee (969 L.).—Revetment has been slightly damaged by waves from steamers, and embankment has been slightly washed. Sacks of earth have been put in by citizens to prevent further injury to levee.

Pecan Grove Levee (973 L.).—Some crayfish leaks have developed; the largest has been worked on by railroad hands. Cribbing was built on river side of embankment and filled with loose earth. The result is not satisfactory.

Story Upper Levee (974 L.).—Some crayfish leaks near lower end of line and slight wave wash near Story crevasse of 1892, but so far nothing serious.

Story Lower Levee (975 L.).—Slight wave wash between Stations 1 and 8. State levee about 2,000 feet above Mexican Gulf Canal; shows some small crayfish leaks.

Repose Levee (976 L.).—Slight wave wash. Large crayfish leak in State levee, near store on Caernarvon plantation, has been stopped with crib on the river side; filled with loose earth. This was done by planters in the vicinity.

Much sipage and many small crayfish leaks from Caernarvon to Stella plantation, State levee. At Stella the front levee has badly washed by waves from steamers. In two places wash extends almost to land edge of crown, and revetment so damaged

as to be practically worthless. However, there is an old abandoned levee about 200 to 250 feet back that might be held should front levee give away.

The same plan in the distribution of inspectors and material for levee protection by local authorities as in the Barataria Levee district.

U. S. barge *A*, transferred from New Orleans harbor, with material thereon, has been used in this district. The U. S. tug *Tilda* used for towing and trips of inspection.

Disposition made for protection work.—The same plan in distribution of material by local boards, as in the Barataria district. United States barge with material thereon will be used in this district also. Tug *Tilda* used for towing and trips of inspection.

Owing to limited funds in this district no work by Government force has been done. Assistance rendered to local authorities will consist principally of towing and the furnishing of expendable material. Eleven hundred sacks have already been distributed in this district.

Very respectfully, your obedient servant,

J. SMYTH, JR.,
Surveyor.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

FLOOD OF 1893.

At the date of this report the water at Vicksburg has reached the extreme height of 48.3 feet, 0.8 foot less than the record for 1890, and exceeding the highest reading of 1891 by 0.2 foot, while it is 0.1 foot less than the highest point reached in 1892. Recent large crevasses in the Middle Tensas Levee district have however afforded at least temporary relief to the river below, and a fall of over a foot and a half has taken place at Vicksburg.

In anticipation of a dangerous flood the following instructions were issued to the assistant engineer in charge of the Atchafalaya, La Fourche, and Pontchartrain Levee districts:

In the event of the river reaching a dangerously high stage this season, the following will be the general plan of operations in applying the funds available for the protection of levees in the Atchafalaya, La Fourche, and Pontchartrain Levee districts.

The large decked barges belonging to the Fourth district plant are to be distributed at points accessible by rail and telegraph, which affords supplies of coal and lumber, and from which the barges may be readily moved to threatened places with a probability of downstream rather than upstream towing.

The points selected for the present are Bayou Sara, Baton Rouge, Plaquemines, Donaldsonville, and Lutcher. Barges may be placed at intermediate points should necessity arise later.

On these barges will be placed a quantity of lumber and sacks to be ready for immediate use.

You are instructed to provide for the care of the barges while waiting calls at their station, in the most economical manner practicable.

The tug *General Comstock* is also assigned for duty in connection with protection work in the above-named districts, under your direction for purposes of towing barges, making inspections, etc. An additional tug or towboat will be provided if needed. The barges, tugs, and material are to be considered as available for all protection service required, both on United States and on State levees, in coöperation with the protection service of the State and district authorities. As it is impracticable to assign barges for service exclusively on one side of the river only it will not be expedient to receive material on them which can not in case of emergency be used at any point of threatened danger in the vicinity and in case material provided by one State levee district is placed on a United States barge and it becomes necessary to use it in another district, the matter of adjusting accounts will be left to the district authorities.

Owing to the limited funds available for protection the assistance rendered by this office will be confined principally to the barge and tug service, and the purchase of expendable material, leaving the providing of tools and labor to the local authorities.

You will keep this office fully informed as to the location and movements of barges and tugs and the application of material.

It must be definitely understood that this office assumes no special responsibility

for old levees in front of proposed or incomplete United States levees, but that the assistance to be rendered will be general and directed towards the maintenance of the entire line as far as practicable.

When barges are taken from their stations for service they should be in charge of an employé of this office until returned.

Similar instructions were issued to assistants in local charge of the other districts, and the disposition of barges, steamboats, etc., contemplated has been made.

A few weak places have developed and some protection work has been done, but at this date no crevasses have taken place in the fourth district.

On the new Lake Concordia levee experiments have been made in stopping leaks through or under the base of the levee by means of sheet piling driven with a floating pile driver. These experiments have been partially successful.

SURVEYS, GAUGES, AND OBSERVATIONS.

Sections have been laid off and soundings taken at different stages of the river, beginning with last low-water season, in the vicinity of the Belmont and Prospect Crevasses of 1892 and also in the straight reach in the river above College Point. These surveys have been under the local charge of Surveyor A. F. Woolley, jr. They were undertaken to determine what changes take place in the river bottom in the vicinity of a crevasse, and also what temporary changes, if any, occur in the river section during the varying stages, in a locality not influenced by crevasses and where the banks are practically permanent.

In addition to the usual low and high water discharge observations near the head of the Atchafalaya, observations to determine the flood discharge of the Mississippi at Red River Landing and at New Orleans are being made.

New features in the high-water discharge work now in progress are the double section, observations being taken on two parallel sections from one-half to 1 mile apart. Accurate observations are also made to determine the actual shape of the river surface at the section. The object of the double sections is to discover and obviate certain discrepancies which have heretofore existed when the observations were confined to a single section.

The river surface of the section has heretofore been assumed to be a straight line and generally a horizontal one. Accurate level observations are being made to test the accuracy of this assumption.

By direction of the commission, surveys were made in January to determine the condition of the levees and cost of restoring them between Warrentown and Grand Gulf, and between Rodney and Coles Creek, on the left bank in what has been designated the Big Black Levee District. No special allotment was made for this survey, and its cost was therefore charged to surveys, gauges, and observations.

In compliance with instructions from the commission, a survey was made in March by Mr. E. B. Geddes, under direction of Assistant Engineer Douglas, to determine the cost of a levee behind Lake Bruin and St. Joseph and the value of the land that would be thrown out. The results of this survey, together with an estimate for bank protection at Hard Times, and opposite the end of Lake Bruin, were submitted in a report of May 2, 1893, with map. Rapid caving near Lake Bruin still continues and attention is again invited to the need of adopting some measures to prevent the river from destroying the levee and breaking into Lake Bruin.

The only regular gauges now maintained under the direction of this office are the ones at Barbres Landing and West Mellville. Their cost is borne from the appropriation for works near Turnbull Island.

Money statement.

June 1, 1892, balance unexpended	$1,381.53
Amount allotted from act approved July 13, 1892	12,000.00
	13,381.53
May 31, 1893, amount expended during fiscal year	6,828.44
May 31, 1893, balance unexpended	6,553.09
Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	12,000.00

The following reports of assistants under allotment for surveys, gauges, and observations are submitted:

Report of low-water discharge measurements in the Atchafalaya River, at Simmesport, La.

Date.	Direction and force of wind.	Simmesport gauge.	Area.	Velocity per second.	Discharge per second.
1892.		*Feet.*	*Square feet.*	*Feet.*	*Cubic feet.*
Oct. 1	Light down stream	6.43	25,290.22	.746	18,880.06
2	....do	6.08	25,710.92	.861	22,138.03
3	....do	5.66	25,232.55	.870	21,957.31
4	Very light cross stream	5.30	25,011.65	.853	21,373.65
5	Brisk down stream	4.80	24,785.30	.981	24,522.18
6	Calm	4.37	24,430.28	.824	20,153.09
7	....do	3.90	24,089.08	.775	18,700.70
8	Brisk cross stream	3.47	24,003.60	.765	18,374.63
10	Light cross stream	2.63	22,796.94	.684	15,584.13
13	Stiff down stream	1.78	22,205.85	.672	14,939.93
15	Strong cross stream	1.57	22,200.00	.603	13,381.46
16	Stiff down stream	1.61	22,137.88	.565	12,506.25

Respectfully submitted.

G. ED. MOTT,
Assistant Engineer.

REPORT OF MR. A. F. WOOLLEY, JR., SURVEYOR, ON SURVEYS, GAUGES, AND OBSERVATIONS.

Barbres Landing, May 31, 1893.

Sir: I have the honor to submit the following report on surveys, gauges, and observations from November 7, 1892, to May 31, 1893:

Prospect Crevasse sections.—By your order of November 6, 1892, I left the Lake Borgne and Barataria levee districts and went to Prospect crevasse and assumed charge of survey in that vicinity.

Thirteen sections were established normal to the river, and extended from the land side of levee on left bank to the land side of levee on the right bank.

A section was established in the center of the crevasse and one at each end of it. Four sections were established above the crevasse and six below it, the extreme upper section being 1¾ miles above and extreme lower section being 2¼ miles below the crevasse.

The greatest distance between sections was 4,200 feet, and are nearer together as the crevasse is approached, being only 600 or 700 feet apart near the crevasse.

Levels were taken on these sections from land side of levee to water's edge on each bank. Three sets of soundings were taken on each section; the first set were taken at low water, the second at medium stage of water, and the third when the water was at the top of its banks.

Two large range signals were placed on shore on each side of a section, and the soundings were taken from a boat which was run above the section, where the lead was cast overboard, and the boat backed just fast enough to have the lead line plumb at the time the section was crossed.

The angle to the lead line, where on section, was recorded with a transit from shore. No attempt was made to locate stations on the section and take soundings on these sections at each successive set of soundings, as the bank, at quite a number of the sections, was covered with a thick growth of willows, and would have necessitated so much clearing to mark the station range.

The soundings were taken sufficiently near together to insure a correct profile of each section. The stage of water was noted as each section was sounded, and the lead line tested often enough to insure good results.

Belmont Crevasse sections.—Thirteen sections were established and sounded, and the same plan followed as at Prospect Crevasse. Assistant Engineer G. Ed. Mott established these sections, took shore levels and first set of soundings; the second and third were taken by me.

All of these sections were to determine the effect of a crevasse on the bed of the river in the vicinity of the crevasse. As yet all sections have not been plotted, and the result is not definitely known.

"*College Point Reach sections.*"—Two sections were established in "College Point Reach," about 7 miles above the Belmont Crevasse, and were to determine the

changes, if any, which take place in the river bed at a point immediately removed from the influence of the crevasse. These sections were little more than half a mile apart, and were located and sounded in the same way as those at "Prospect" and "Belmont." Soundings have not all been plotted, and the result is not known.

During low water the steamer *Ruby* was used for this work and the tug *General Comstock* was used during the high stages of water.

The survey party employed on these surveys consisted of three men and myself, until the shore work was completed; after that I had only two men exclusive of boat's crew.

"Old River."—Between the dates of April 28 and May 3, 1893, I took three sets of mid-channel soundings around Turnbulls Island and out to the Mississippi. There were two points in Lower Old River, between the foot of the island and Ash Cabin Light, which were less than 5 feet below the zero of Barbres gauge. After being plotted over a previous set of soundings, the soundings last taken indicate a deeper channel generally through both "Lower Old River" and "Upper Old River." The steamer *Ruby* was used on this survey.

"Discharge observations, Mississippi River," Red River Landing, La.—This work was begun on May 15, 1893. The original section at Red River Landing was resounded and 23 observation stations were located, being two more than formerly used.

In addition to the original section at Red River Landing, I located a section about half a mile above, and established 23 observation stations on this section also. The discharge of both these sections was always taken on the same day, so that they might be a check against each other. The water was just coming over the banks when I commenced this work and much difficulty in putting up ranges was encountered.

These discharges are yet underway, as the highest stage of water has not yet passed. Up to date only seven discharges for the Mississippi have been taken, and none have been computed, as the amount of field work I have had to perform has left me no time for computations.

"Discharge observations, Atchafalaya River," Simmesport, La.—The original discharge section at this point was used, and additional section about half a mile downstream was established as a check against the original section. The discharge for both these sections are taken on the same day.

Precise levels are taken at each end of section for water surface at time of discharge, and water surface not assumed to be same elevation all the way across the section as heretofore done.

In taking these levels, correction for curvature and refraction was made. These levels were taken for both Mississippi and Atchafalaya discharge.

The *Lotus* was first used for taking these discharges, but her pump broke on the 27th of May, and the work is being continued with the *Ruby*. Up to date only three discharges of the Atchafalaya, and none of them have been computed.

Respectfully submitted.

A. F. WOOLLEY, JR.,
Surveyor.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The results of the above surveys will be reported when completed by soundings during next low-water season.

COMMERCIAL STATISTICS.

The statistics relating to the foreign commerce of the port of New Orleans were kindly furnished by Hon. H. C. Warmoth, collector of customs.

Statement showing the approximate receipts and shipments of freight by river from June 1 1892, to June 1, 1893.

[Compiled from information derived from the commercial exchanges of the representative towns, and the several business houses and landings where the steamboats receive and discharge cargoes, and from the records of the custom-house, port of New Orleans, La.]

NATCHEZ, MISS.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Cotton ..... bales..	12,602	2,520	$378,060
Cotton seed ..... sacks..	45,000	2,225	22,500
Coal ..... bushels..	2,400,000	85,990	307,125
Flour ..... barrels..	20,460	2,041	61,380
Corn ..... sacks..	50,820	3,811	88,935
Oats ..... do...	80,532	7,247	201,330
Lumber ..... feet, B. M..	6,500,000	11,375	97,500
Miscellaneous ..... packages..	92,638	8,565	311,959
Total	.....	123,784	1,469,089
Shipments.			
Cotton ..... bales..	8,520	1,704	255,600
Corn ..... sacks..	41,322	3,075	11,750
Cotton-seed meal ..... do...	18,534	1,080	13,875
Flour ..... barrels..	15,767	1,600	47,301
Lumber ..... feet, B. M..	1,500,000	2,625	22,500
Oats ..... sacks..	70,885	6,390	177,500
Miscellaneous ..... packages..	404,407	9,920	639,745
Total	.....	26,394	1,168,271

For comparison the statistics of 1891 and 1892 are also given. In connection therewith see foot notes.

NATCHEZ, MISS.

	1891.	1892.	1893.
Number of steamboats in the trade	38	32	29
Number of times arrived	819	1,008	828
Number of times departed	717	1,008	828
Number of barges	52	49	45
Total cargo received ..... tons..	106,961	123,830	123,784
Value of same	$1,734,027.00	$1,988,169.30	$1,469,089.00
Total cargo shipped ..... tons..	28,104	30,786	26,394
Value of same	$1,095,890.00	$1,037,281.66	$1,168,271.00
Total cargo received and shipped ..... tons..	135,065	154,616	150,178
Value of same	$2,829,917.00	$3,025,550.96	$2,637,360.00

NOTE.—The general business at Natchez has decreased about 5 per cent since last year, and it is attributed by the authorities to the protracted high water of 1892, which had considerable effect on local trade. The tonnage received for Natchez, however, seems to be very nearly the same as in previous reports, and is probably due to the increased coal business, which forms an important item.

Statement showing the approximate receipts and shipments of freight, etc.—Continued.

VIDALIA, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts and shipments.			
Cotton ..... bales..	5,000	1,000	$150,000
Cotton seed ..... sacks..	47,000	2,350	23,500
Corn ..... do....	6,500	487	11,375
Coal ..... bushels..	30,000	1,050	3,750
Flour ..... barrels..	2,100	210	6,300
Molasses ..... do....	200	60	3,000
Lumber ..... feet, B. M..	225,000	393	3,375
Staves	300,000	4,350	49,500
Oats ..... sacks..	5,500	495	13,750
Miscellaneous ..... packages..	26,060	1,072	196,700
Sugar ..... barrels..	450	73	6,750
Total	.....	11,540	468,000

	1891.	1892.	1893.
Number of steamboats in the trade	38	32	29
Number of times they have landed	819	1,008	828
Number of barges	2	12	3
Total cargo received and shipped ..... tons..	12,392	17,329	11,540
Value of same	$781,976.75	$887,137.00	$467,060.60

NOTE.—The general business at Vidalia has decreased about 5 per cent since last year, and it is attributed by the authorities to the protracted high water of 1892, which had considerable effect on local trade. The tonnage received for Vidalia, however, seems to be very nearly the same as in previous reports, and is probably due to the increased coal business, which forms an important item.

BAYOU SARA, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Cotton ..... bales..	350	70	$10,530
Corn ..... sacks..	3,000	225	5,250
Coal ..... bushels..	250,000	8,750	8,750
Flour ..... barrels..	4,500	450	13,500
Lumber ..... feet, B. M..	75,000	141	1,125
Molasses ..... barrels..	400	120	6,000
Oats ..... sacks..	8,500	765	21,250
Rice ..... barrels..	650	78	7,300
Sugar ..... do....	2,200	362	33,000
Cotton ties ..... bundles..	2,700	75	3,375
Miscellaneous ..... packages..	50,607	3,402	197,312
Total	.....	14,438	307,892
Shipments.			
Cotton ..... bales..	2,200	440	66,000
Cotton seed ..... sacks..	75,000	3,750	37,500
Corn ..... do....	2,100	157	3,675
Coal ..... bushels..	78,000	2,730	9,750
Flour ..... barrels..	1,450	145	4,350
Lumber ..... feet, B. M..	360,000	630	5,400
Molasses ..... barrels..	65	19	975
Oats ..... sacks..	7,000	630	17,500
Rice ..... barrels..	110	18	1,320
Sugar ..... do....	310	50	4,650
Cotton ties ..... bundles..	900	25	1,125
Miscellaneous ..... packages..	26,838	1,831	126,202
Total	.....	10,420	278,587

Statement showing the approximate receipts and shipments of freight, etc.—Continued.

BAYOU SARA, LA.—Continued.

	1891.	1892.	1893.
Number of steamboats in the trade	48	40	36
Number of times arrived	1,019	800	894
Number of times departed	747	685	894
Number of barges	17	18	23
Total cargo received tons	29,321	14,041	14,438
Value of same	$1,113,719	$360,374	$307,892
Total cargo shipped tons	19,040	11,690	10,420
Value of same	$1,193,396	$129,455	$278,537
Total cargo received and shipped tons	49,261	25,731	24,858
Value of same	$2,307,115	$489,829	$586,429

BATON ROUGE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Cotton bales	725	145	$21,750
Cotton seed sacks	126,500	6,325	63,250
Corn do	50,000	3,750	87,500
Coal bushels	1,000,000	35,000	125,000
Flour barrels	65,000	6,500	195,000
Lumber feet, B. M	15,500,000	27,125	232,500
Molasses barrels	1,200	360	18,000
Moss bales	5,525	207	2,762
Oats sacks	70,300	6,300	175,000
Rice barrels	1,200	144	14,400
Sugar do	3,300	536	49,500
Cotton ties bundles	8,600	240	10,750
Miscellaneous packages	252,972	11,982	1,077,640
Total		98,614	1,073,052
Shipments.			
Cotton bales	12,300	2,460	369,000
Cotton-seed meal sacks	13,300	798	9,975
Cotton seed do	18,000	900	9,000
Coal bushels	900,000	31,500	112,500
Corn sacks	75,000	5,625	131,250
Flour barrels	27,650	2,763	83,000
Lumber feet, B. M	3,500,000	6,125	52,500
Moss bales	5,330	199	2,665
Molasses barrels	5,620	1,686	114,300
Oats sacks	29,450	2,055	73,625
Rice barrels	830	100	9,960
Sugar do	20,000	3,250	300,000
Cotton ties bundles	1,500	42	1,875
Miscellaneous packages	3,003,715	82,419	841,002
Total		140,522	2,111,542

BATON ROUGE, LA.

	1891.	1892.	1893.
Number of steamboats in the trade	49	37	32
Number of times arrived	895	732	980
Number of times departed	693	552	980
Number of barges	108	146	165
Total cargo received tons	23,313	346,068	98,614
Value of same	$2,257,360	$3,280,558	$1,973,052
Total cargo shipped tons	60,787	65,684	140,522
Value of same	$1,737,434	$1,252,394	$2,111,542
Total cargo received and shipped tons	84,100	411,932	239,135
Value of same	$3,994,794	$4,532,952	$4,084,594

NOTE.—The decrease in the receipts at Baton Rouge is attributed, by the authorities, to railroad competition, the immense falling off of the coal business due to labor difficulties and the discontinuance of one of the lumber mills. The increase in shipments probably can be accounted for by the numerous levee contractors in the vicinity, who consumed large quantities of grain feed and provisions.

Statement showing the approximate receipts and shipments of freight, etc.—Continued.

PLAQUEMINE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Corn ..... sacks..	12,000	900	$21,000
Cotton-seed meal ..... do....	6,800	408	5,100
Coal ..... bushels..	375,000	13,125	46,875
Flour ..... barrels..	16,320	1,632	48,960
Molasses ..... do....	630	189	9,450
Moss ..... bales..	50	2	25
Oats ..... sacks..	12,000	1,080	30,000
Rice ..... barrels..	2,850	342	34,200
Sugar ..... do....	1,500	243	22,500
Miscellaneous ..... packages..	118,640	6,216	377,313
Total	.....	24,137	595,423
Shipments.			
Coal ..... bushels..	1,000,000	35,000	125,000
Corn ..... sacks..	2,800	210	4,900
Lumber ..... feet, B. M..	6,238,324	10,916	9,570
Molasses ..... barrels..	8,000	2,400	120,000
Moss ..... bales..	2,500	93	1,250
Oats ..... sacks..	6,200	558	4,960
Rice ..... barrels..	850	102	10,200
Sugar ..... do....	1,380	224	20,700
Flour ..... do....	7,800	780	23,400
Miscellaneous ..... packages..	828,974	12,110	319,134
Total	.....	62,393	1,264,614

PLAQUEMINE, LA.

	1891.	1892.	1893.
Number of steamboats in the trade	50	53	39
Number of times arrived	453	428	560
Number of times departed	388	402	560
Number of barges	52	66	30
Total cargo received ..... tons..	61,110	82,214	24,137
Value of same	$819,176	$1,023,243	$595,423
Total cargo shipped ..... tons..	57,809	45,234	62,393
Value of same	$596,899	$833,479	$1,264,614
Total cargo received and shipped ..... tons..	119,009	127,448	86,530
Value of same	$1,416,075	$1,856,722	$1,860,037

NOTE.—The decrease in the receipts at Plaquemine is attributed to successful railroad competition and immense falling off in the receipts of coal due to labor troubles at the mines during the year.

DONALDSONVILLE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Corn ..... bushels..	8,300	622	$14,525
Coal ..... do....	1,425,000	119,875	428,125
Flour ..... barrels..	720	72	2,160
Lumber ..... feet, B. M..	5,060	8	75
Molasses ..... barrels..	20	6	300
Oats ..... sacks..	12,600	1,138	31,500
Rice ..... barrels..	1,030	123	12,360
Sugar ..... do....	500	81	7,500
Miscellaneous ..... packages..	15,680	880	107,994
Total	.....	122,805	604,539
Shipments.			
Coal ..... bushels..	3,675,000	128,625	459,375
Molasses ..... barrels..	45,000	13,500	675,000
Sugar ..... do....	180,000	29,250	2,700,000
Rice, rough ..... sacks..	82,000	2,460	164,000
Miscellaneous ..... packages..	2,331	817	10,407
Total	.....	174,652	4,008,782

Statement showing the approximate receipts and shipments of freight, etc.—Continued.

DONALDSONVILLE, LA.—Continued.

	1891.	1892.	1893.
Number of steamboats in the trade	41	36	42
Number of times arrived	963	884	885
Number of times departed	591	378	402
Number of barges	104	132	121
Total cargo received.....tons..	105,172	158,296	122,805
Value of same	$929,570	$1,829,128	$604,549
Total cargo shipped.....tons..	6,059	113,205	174,652
Value of same	$482,700	$2,201,460	$4,008,782
Total cargo received and shipped.....tons..	111,231	271,501	296,457
Value of same	$1,412,270	$4,030,588	$4,612,331

NOTE.—General depreciation of receipts due to successful railroad competition. The shipments of sugar and molasses have increased, and the coal business is also enlarging rapidly, due to the fact that Donaldsonville is becoming yearly more generally adapted as a shipping station for inland consumers and those along Bayou La Fourche; hence the marked increase in the shipments as shown.

The above towns are, strictly speaking, "way points" and not termini, and the net tonnage or carrying capacity of the steamboats that do business at those places is not given, as it would not show the proper relation between what would then be made the possible tonnage and actual tonnage brought.

All New Orleans steamboats are counted "arrived" when they stop on their journey up river, and "departed" when they stop on their way down to New Orleans.

The St. Louis and Ohio River steamboats are counted "arrived" when they stop on their journey down the river, and "departed" when they stop on their way up stream.

Statement showing the amount and value of commerce passing out of Red River and its tributaries through Old River into the Mississippi River.

[Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans, La.]

OLD RIVER.

Articles.	Quantity.	Tonnage.	Value.
Cotton.....bales..	95,604	19,138	$2,879,820
Cotton seed.....sacks..	196,174	9,808	147,120
Cotton-seed meal.....do....	104,059	5,202	119,646
Cotton-seed oil.....barrels..	1,941	242	38,830
Lumber.....feet, B. M..	3,636	5	44
Molasses.....barrels..	15,628	4,688	234,420
Moss.....bales..	2,571	96	1,285
Rice.....sacks..	20,499	1,537	40,988
Sugar.....hogsheads..	2,444	1,466	117,312
Sugar.....barrels..	34,466	5,600	516,990
Staves (oak).....number..	1,104,419	5,522	16,566
Miscellaneous.....packages..	15,092	554	64,836
Total.....	.....	53,858	4,189,647

	1891.	1892.	1893.
Number of steamboats in the trade	17	24	17
Trips made by them	501	279	342
Net tonnage of same	101,604	91,043	78,571
Number of barges	24	8	19
Net tonnage of same	14,400	7,600	18,050
Total tonnage of steamboats and barges	116,004	98,643	91,621
Total cargo brought.....tons..	92,232	90,886	53,858
Value of same	$10,951,108	$9,458,901	$4,168,847

NOTE.—This does not include the upstream freights, which must be nearly equal to the downstream in value.

Statement showing the receipts, by river, at New Orleans, La.

[Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans.]

Articles.	Quantity.	Tonnage.	Value.
Above the city.			
Coal.....bushels..	4,428,000	154,980	$553,500
Cotton seed.....sacks..	891,080	44,554	668,310
Cotton.....bales..	190,419	38,083	5,717,570
Cotton-seed meal.....sacks..	126,077	6,300	144,949
Cotton-seed oil.....barrels..	3,783	472	75,660
Flour.....do....	209,416	20,941	628,248
Flour.....one-half barrels..	31,700	1,585	55,475
Flour.....sacks..	71,780	1,794	53,835
Corn.....bushels..	4,016,744	112,468	2,410,046
Oats.....do....	352,417	5,654	141,366
Cotton ties.....	400,000	12,000	5,000
Lumber.....feet, B. M..	10,536	15	126
Molasses.....barrels..	190,506	57,151	1,857,590
Moss.....bales..	7,443	372	18,607
Rice.....barrels..	659	79	7,908
Rice.....sacks..	227,035	17,027	454,070
Sugar.....hogsheads..	39,859	23,915	1,913,232
Sugar.....barrels..	433,306	70,412	6,499,590
Staves.....	1,750,724	8,753	262,608
Wheat.....bushels..	2,273,516	158,205	3,955,137
Miscellaneous.....packages..	857,684	72,086	2,244,918
Total.....	.....	806,846	27,662,765
Below the city.			
Molasses.....barrels..	4,553	1,335	60,795
Moss.....bales..	321	12	160
Rice, clean.....barrels..	10	1	120
Rice, rough.....sacks..	29,523	2,224	59,046
Sugar.....barrels..	17,818	2,896	267,270
Miscellaneous.....packages..	181,853	31,184	363,160
Total.....	.....	37,652	759,551

	1891.	1892.	1893.
Above the city.			
Number of steamboats	51	54	51
Trips made by them	1,417	1,090	1,203
Net tonnage of same	665,610	450,031	542,156
Towboats	45	39	32
Trips made by them	134	168	108
Net tonnage of same	51,810	90,544	46,357
Number of barges	929	1,042	568
Net tonnage of same	418,050	468,900	255,600
Number of luggers (sailing)	18	20	25
Trips made by them	162	240	650
Net tonnage of same	4,860	5,400	3,900
Total tonnage (steamboats, towboats, barges, and luggers)	1,140,330	1,014,875	848,013
Total cargo brought.....tons..	1,343,061	1,303,628	806,846
Value of same	$54,332,685	$56,076,160	$27,662,765
Below the city.			
Number of steamboats in local trade	6	6	6
Trips made by them	321	174	286
Net tonnage of same	31,039	17,916	26,077
Luggers (sailing in local trade)	218	278	100
Trips made by them	4,250	2,892	2,600
Net tonnage of same	130,000	73,672	15,600
Total tonnage (steamboats and luggers)	161,839	91,588	41,677
Total cargo brought.....tons..	22,422	8,632	37,652
Value of same	$1,729,092	$741,155	$759,551

Statement showing the receipts, by river, at New Orleans, La.—Continued.

RECAPITULATION.

	1891.	1892.	1893.
Total arrivals (steamboats, tow boats, barges, and luggers) above and below the city	7,193	5,398	5,395
Total net tonnage, above and below	1,502,169	1,106,463	889,699
Total cargo brought above and below.....tons	1,365,483	1,312,260	844,498
Value of same	$56,061,000	$56,817,315	$28,422,316

The foregoing includes simply the freights brought to New Orleans by steamboats and barges and luggers on the Mississippi River and does not include the large and valuable freights that they take away. No record is kept of this, and it is impossible to furnish even a reasonably accurate estimate of its value. It would amount to a very large sum in the aggregate, probably more than 40 per cent of the value of freights received at New Orleans.

Foreign commerce, port of New Orleans.

Vessels.	Entrances.			Clearances.		
	1890–'91.	1891–'92.	1892–'93.	1890–'91.	1891–'92.	1892–'93.
Steam	1,005	1,245	1,131	1,007	1,242	1,084
Sail	154	161	135	141	136	110
Total	1,159	1,406	1,266	1,148	1,378	1,194

Total tonnage of above:

	Tons.
1890–'91	2,827,295
1891–'92	3,542,599
1892–'93	2,962,798

EXPORTS AND IMPORTS.

	1891.	1892.	1893.
Total value of exports of foreign merchandise to foreign countries	$1,099,259	$1,911,081	$478,983
Total value of exports of domestic merchandise to foreign countries	108,007,428	130,183,916	81,812,507
Grand total of exports of foreign and domestic merchandise to foreign countries	109,106,687	132,094,997	82,291,500
Total value of imports from foreign countries:			
Free	13,211,083	14,878,800	22,907,192
Dutiable	7,041,959	5,442,415	3,912,923
Specie	513,294	305,402	596,458
Grand total	20,766,336	20,626,617	27,416,573

TOTAL DUTIES COLLECTED.

1891	$2,106,681.43
1892	1,593,070.59
1893	1,509,309.12

Approximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, Fourth district, May 31, 1893.

Class of property.	Value.	Class of property.	Value.
Steamer General Newton	$12,000	One warehouse barge	$2,200
Steam launch Ruby	4,000	One warehouse barge	200
Steam tug General Comstock	7,000	Fifteen row boats	260
Steam tug Tilda	6,000	Tools and appliances	16,000
Steam launch Alaska	3,500	Office furniture	2,000
Steam launch No. 5	2,000	Surveying instruments	2,600
One dredge boat	10,000	Drawing instruments	200
Four dump scows	8,000	Railway cars and tracks	1,900
Five quarter boats	12,000		
Thirty barges	58,734	Total	148,534

List of civilian engineers on work of river and harbor improvements in charge of Capt. John Millis, Corps of Engineers, to May 31, 1893, inclusive.

Name and residence.	Time employed.		Compensation per month.	Where employed.	Work on which employed.
	Mos.	*Days.*			
H. S. Douglas, Natchez, Miss.	12	0	$200	Natchez, Miss	Levees, Lower Tensas and Big Black levee districts, and gauges.
W. G. Price, New Orleans, La.	6	16	200	New Orleans, La	Levees, Lake Borgne and Barataria levee districts.
W. J. Hardee, Baton Rouge, La.	6	16	175	Baton Rouge, La	Levees, Atchafalaya, Lafourche, and Pontchartrain levee districts.
	5	14	200		
William Garvin, New Orleans, La.	12	0	175	New Orleans, La	Improving harbor at New Orleans, La.
G. Ed. Mott, New Orleans, La.	5	15	150	Red River Landing and Simmesport, La.	Surveys, gauges, and observations.

The following maps and drawings accompany and form part of this report:

PLATE I.—Harbor of Natchez and Vidalia, Mississippi and Louisiana.
PLATE II.—Turnbull Island and vicinity.
PLATE III.—Carrollton Bend, New Orleans Harbor.
PLATE IV.—Southport to Exposition Wharf, New Orleans Harbor.
PLATE V.—Lower Tensas and Big Black levee districts.
PLATE VI.—Atchafalaya, LaFourche, and Pontchartrain levee districts.
PLATE VII.—Barataria and Lake Borgne levee districts.
PLATE VIII.—Method of closing crevasses.
PLATE IX.—Levee sections.
PLATE X.—Area of overflow, flood of 1892.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Col. C. B. COMSTOCK,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

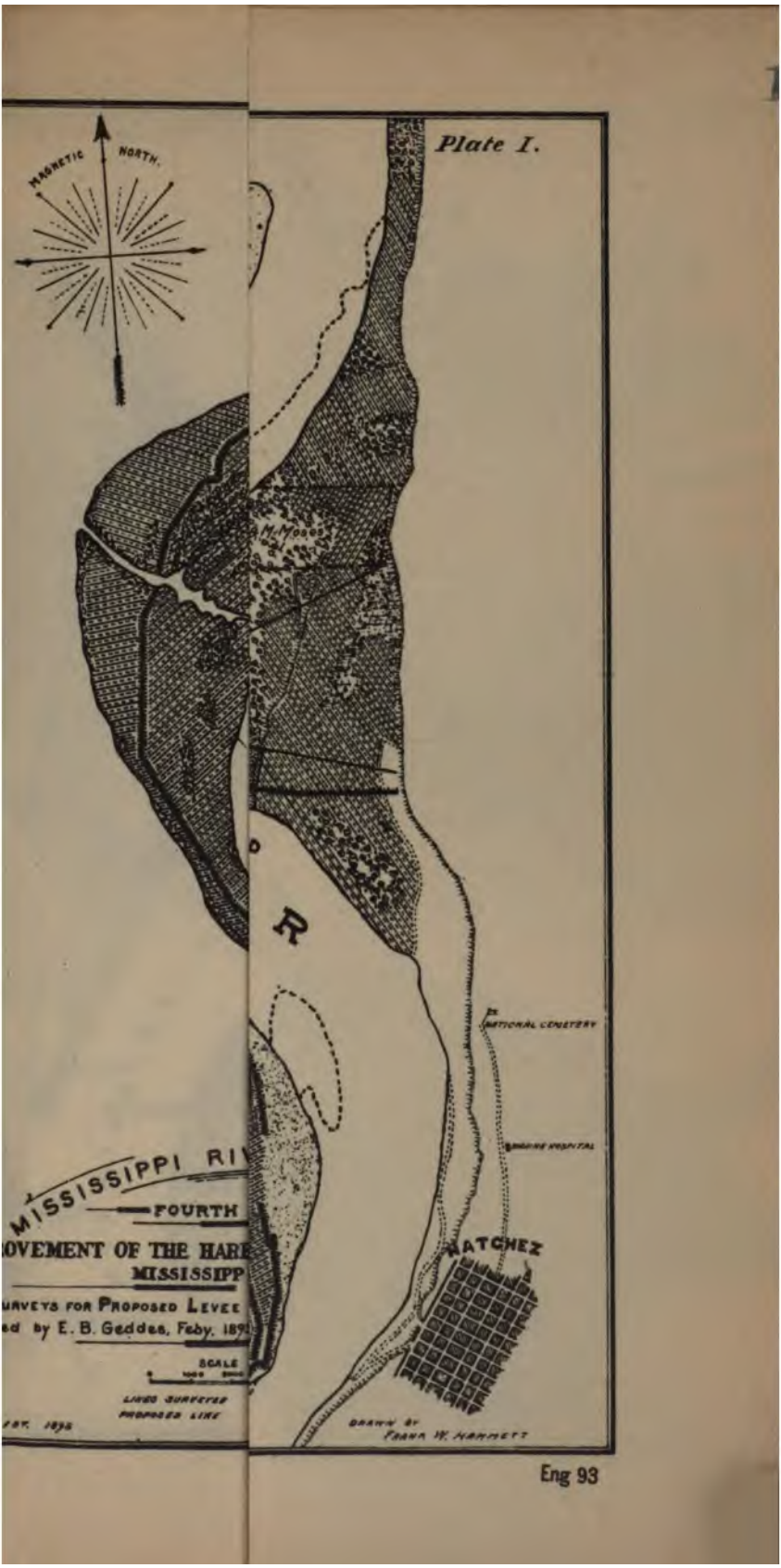
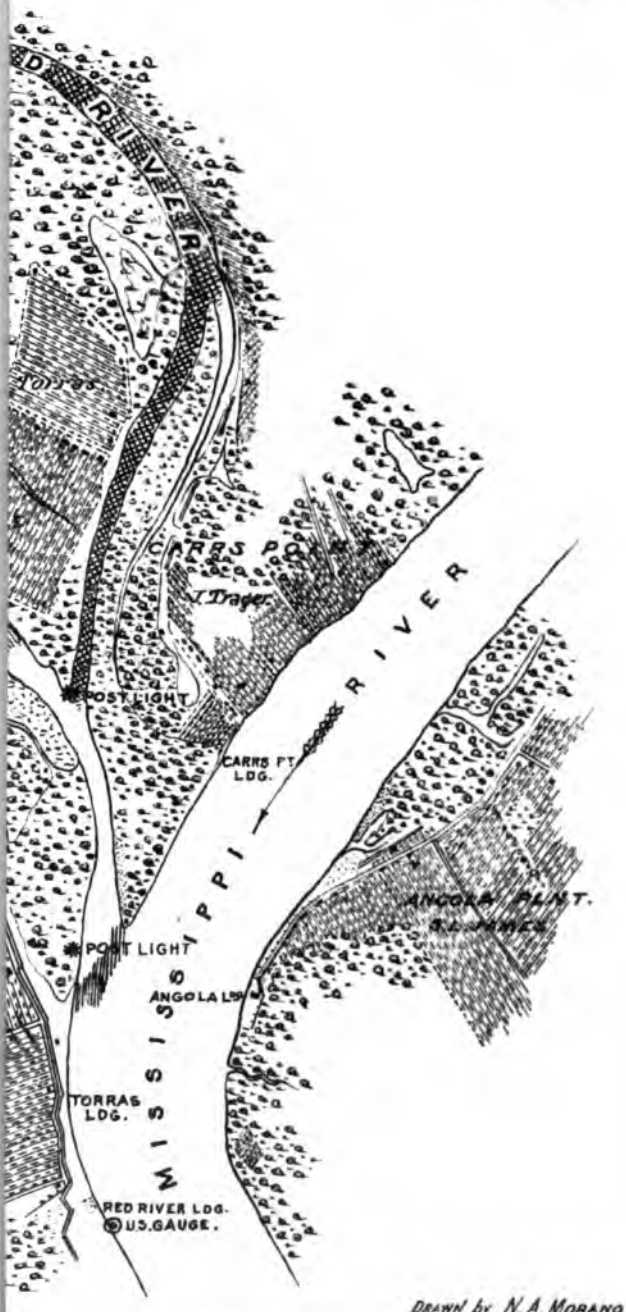


Plate I.
MAGNETIC
NORTH.
MISSISSIPPI RI
FOURTH
OVEMENT OF THE HARB
MISSISSIPP
URVEYS FOR PROPOSED LEVEE
ed by E. B. Geddes, Feby. 189
SCALE
LINES SURVEYED
PROPOSED LINE
NATIONAL CEMETERY
NATCHEZ
DRAWN BY
FRANK W. HARRIETT

Eng 93

Plate II.



Eng 93

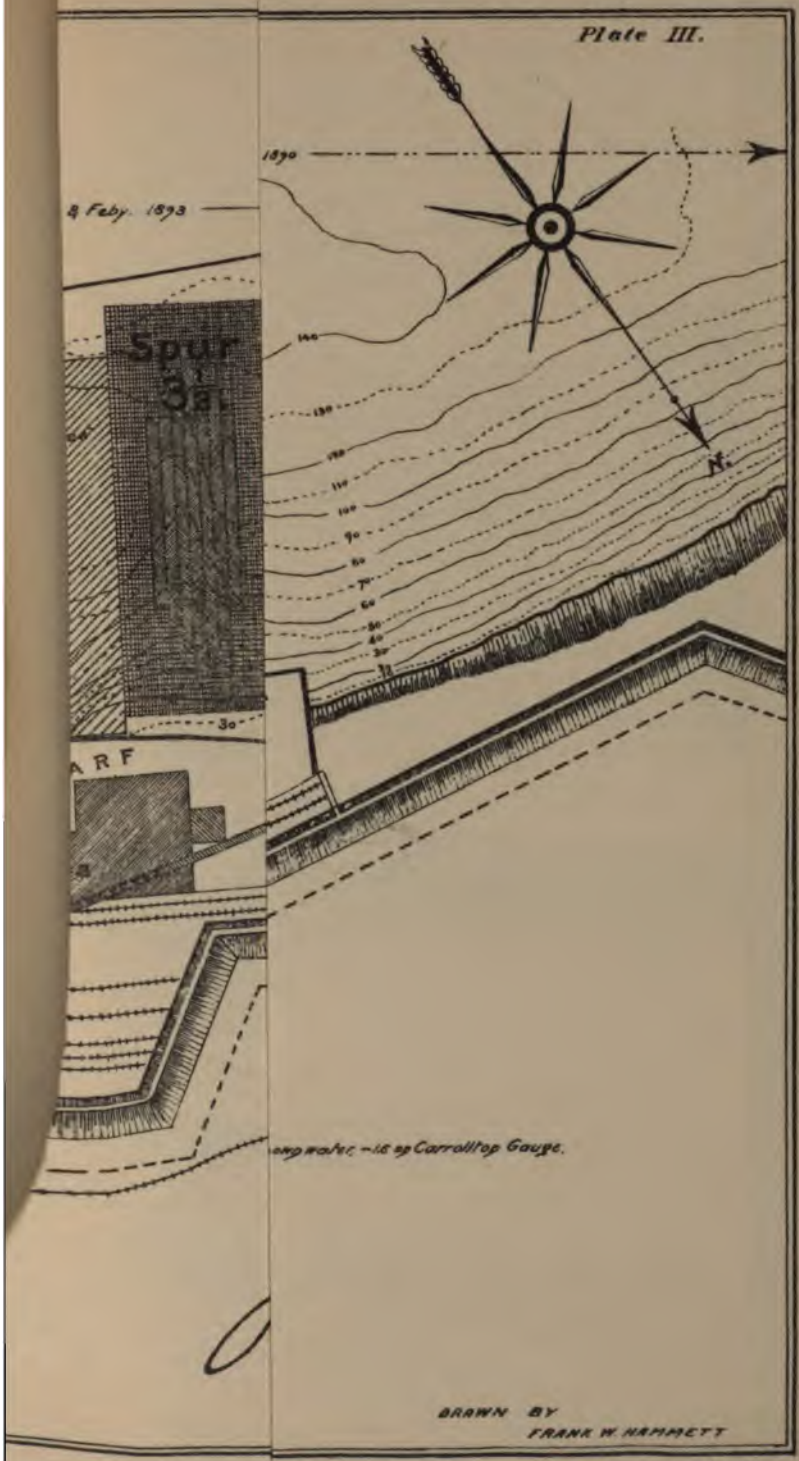


Plate III.
1890
4 Feby. 1893
Spur
3
3a
N.
ARF
Carrollton Gauge.
DRAWN BY
FRANK W. HAMMETT

Eng 93

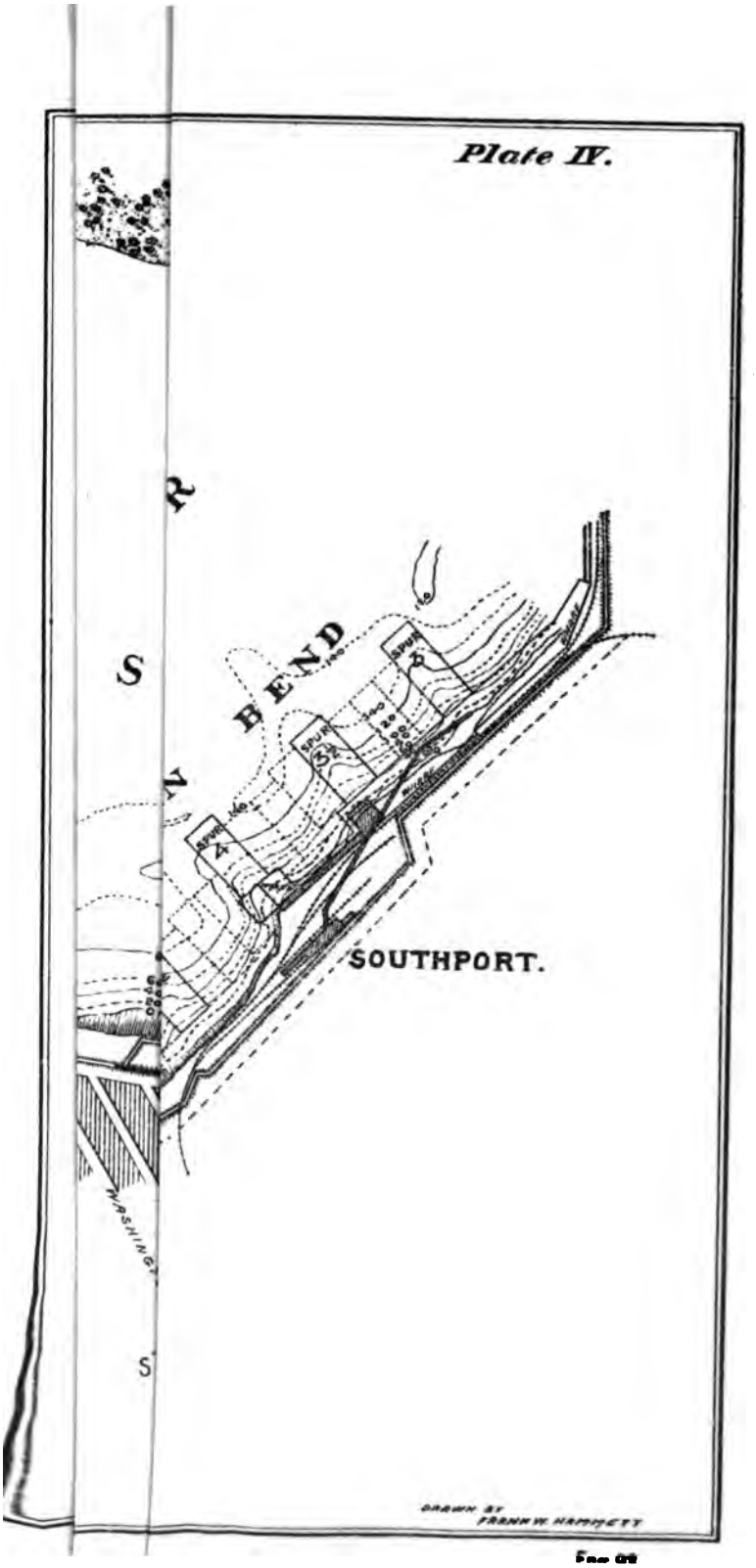


Plate IV.
S
HEND
SOUTHPORT.
DRAWN BY
FRANK W. HAMMETT

31°12'
31°09'
30°57'
LOUISIANA
WEST FELICIANA PARISH
91°36'
91°39'
30°57'
91°42'
91°45'
31°00'
91°48'
91°51'
31°03'
91°54'
91°57'
31°06'
92°00'
TURK BULL ISLAND
PARISH
RIVER
PRSH
5
91°31'57"
92°00'

Eng. 93

LEVEE DIST.
NEW ORLEANS
CORNLAND 1890-91
PEARL HAVEN TO HOUMA 1890-91
HOUMA 1892-93
BOURGEOIS 1891-92
TERREBONNE 1892-93
DIEK 1891-92
WATCHE
WILLOW BEND
GRANDVILLE REACH
HOUMA REACH 1892-93
LAFC
90°51'
90°48'
90°45'
90°24'
90°21'

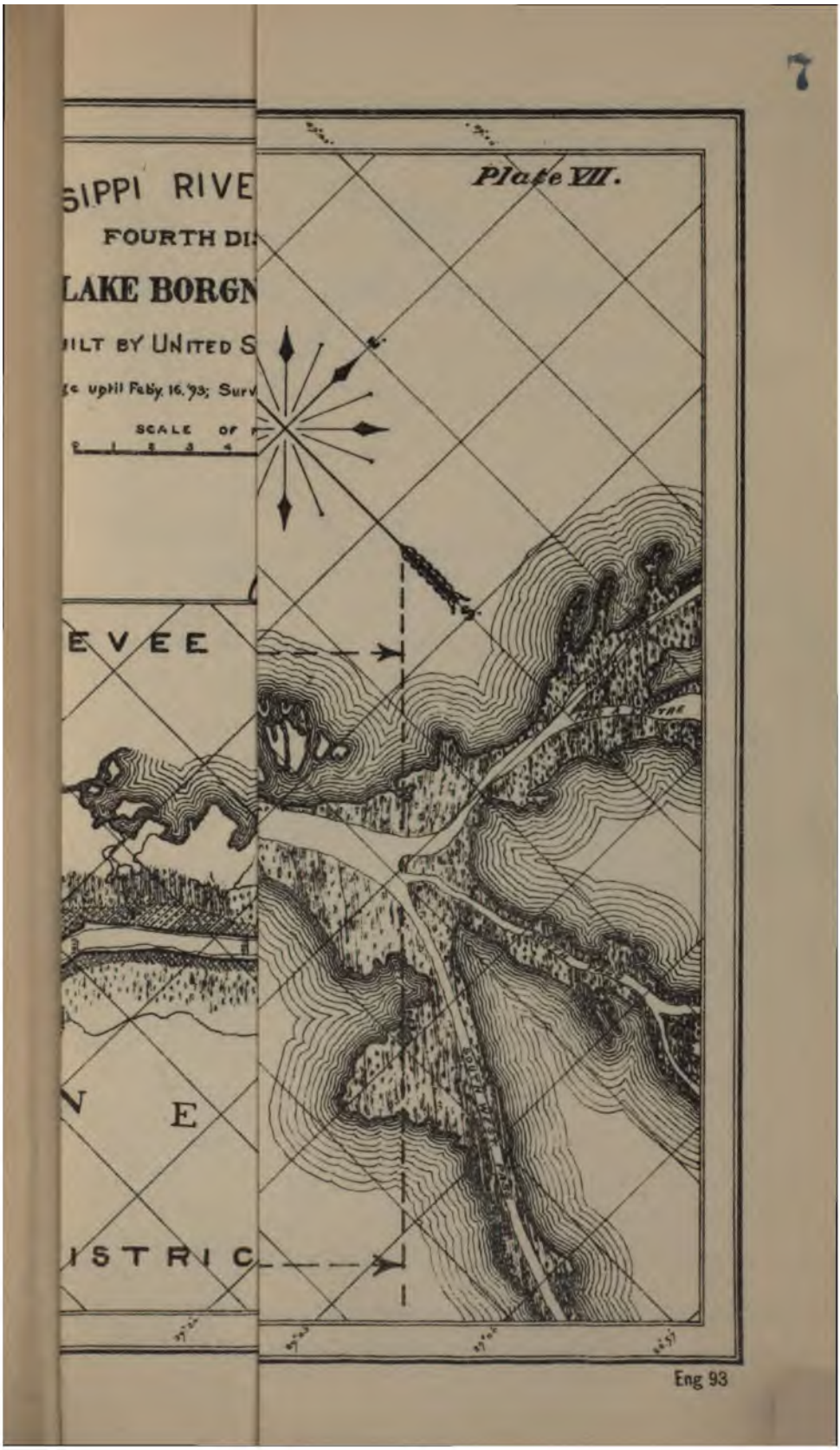
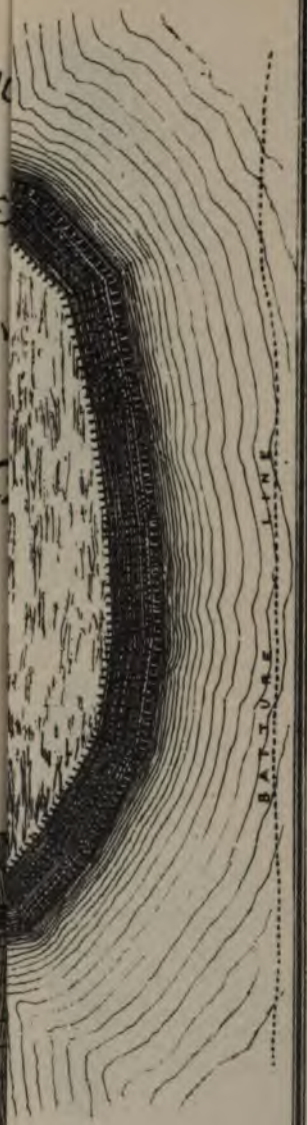


Plate VII.
SIPPI RIVE
FOURTH DI
LAKE BORGN
ILT BY UNITED S
SCALE OF
EVEE
ISTRIC

Eng 93

Plate VIII.

RIVER COMMISSI
TH DISTRICT
OWING METHOD OF
& CREVASSE
D OF 1892
of Asst. Engineer
OR FIGS. 1, 2, 3.



PLAN

FIG. 3.

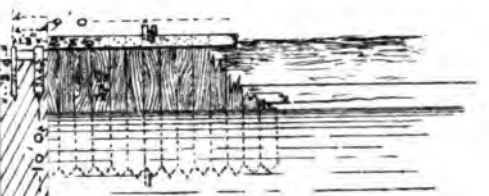
VATION From River

RAWN BY N.A. MORANO.

Eng 93

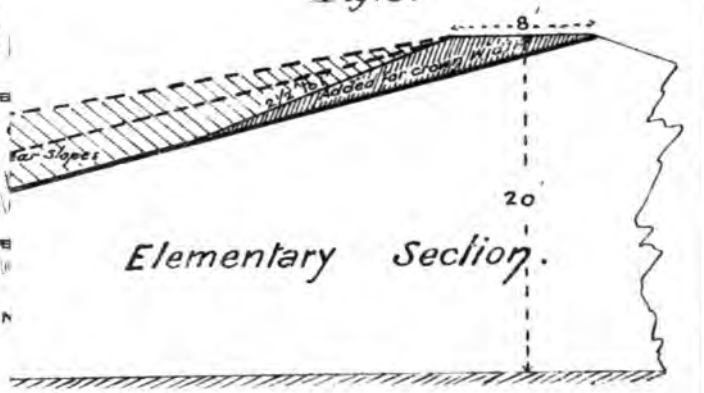
RON

Plate IX.



OF REVETMENT.

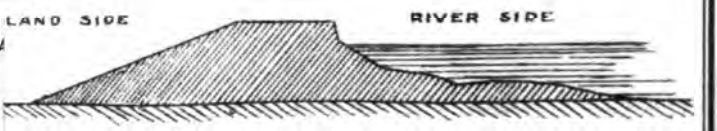
Fig. 8.



Elementary Section.

SS

ECTION OF LEVEE WAVE WASHED
FLOOD 1892.
Fig. 10.



Drawn by B.J. OLIVEIRA.

Eng 93

INDEX.

[The references in Roman are to part (or volume), and those in Arabic to page.]

A.

Aberdeen, Wash., establishment of harbor lines at.....I, 463; IV, 3472, 3477
Absecon Inlet, N. J., removal of wreck near.....I, 128; II, 1182
Adams Landing, Vt., examination of harbor at.....I, 419; IV, 3215
Agate Bay Harbor, Minn., improvement of.....I, 336; IV, 2654
Ahnapee Harbor, Wis., improvement of.....I, 350; IV, 2721
Aitken, Kate V. (schooner), removal of wreck of.....I, 189; II, 1531
Alabama River, Ala., improvement of.....I, 222; II, 1718
Alaqua Bayou, Fla., examination of bar at mouth of.....I, 228; II, 1738
Albemarle Sound, N. C.:
  Improvement of waterway between Norfolk Harbor, Va., and.....I, 164; II, 1341
  Removal of wreck in.....I, 183; II, 1449
Allegheny River:
  Bridge at New Kensington, Pa., across, construction of.....I, 470
  Examination for lock and dam at Tarentum, Pa.....I, 319; III, 2538
  Examination for lock and dam between Herr Island Dam and Tarentum, Pa.....I, 319; III, 2535
  Examination of, between Olean, N. Y., and Warren, Pa.....I, 319; III, 2540
  Herr Island Dam, Pa., construction of.....I, 316; III, 2501
  Improvement of, Pa.....I, 315; III, 2498
Allen, R. A. (barge), removal of wreck of.....I, 69, 854
Allouez Bay, Wis.:
  Establishment of harbor lines in.....I, 462; IV, 2695
  Examination of.....I, 344; IV, 2692
Alloway Creek, N. J., improvement of.....I, 127; II, 1176
Alpena Harbor, Mich., improvement of.....I, 381; IV, 2922
Alsea River, Oregon, examination of inner navigation of.....I, 445; IV, 3440
Altamaha River, Ga.:
  Construction of bridge across.....I, 468
  Improvement of.....I, 193; II, 1561
Alva (steam yacht), removal of wreck of.....I, 70, 857
Alviso Slough, Cal., examination of.....I, 425; IV, 3236
Amite River, La., improvement of.....I, 241; III, 1812
Anacortes, Wash., establishment of harbor lines at.....I, 463; IV, 3472
Anacostia River, D. C., improvement of.....I, 148; II, 1265
Ann, Cape, Mass., improvement of harbor of refuge at Sandy Bay.....I, 41, 748
Apalachicola Bay, Fla., improvement of.....I, 211; II, 1690
Apalachicola River, Fla., improvement of.....I, 212; II, 1692
Appomattox River, Va.:
  Examination of, at Petersburg.....I, 166; II, 1345
  Improvement of.....I, 163; II, 1333
Apponaug Harbor, Cowesset Bay, R. I., examination of.....I, 71, 869
Appoquinimink River, Del., improvement of.....I, 131; II, 1197
Aquia Creek, Va., improvement of.....I, 151; II, 1286
Arkansas River:
  Improvement of.....I, 272; III, 2103
  Removal of wreck at Van Buren, Ark.....I, 279; III, 2121
  Removing obstructions in.....I, 272; III, 2102
Arthur Kill, N. Y. and N. J.:
  Examination for channel to connect mouth of, with New York Harbor.....I, 105, 1083
  Improvement of.....I, 108, 1104
Arthur, Lake, La., improvement of.....I, 246; III, 1828

Ashland Harbor, Wis., improvement of ..... I, 340; IV, 2674
Ashley River, S. C.:
Improvement of ..... I, 188; II, 1512
Removal of wreck in ..... I, 189; II, 1531
Ashtabula Harbor, Ohio, improvement of ..... I, 402; IV, 3095
Atlantic City, N. J., removal of wreck near ..... I, 128; II, 1182

B.

Back Bay (Biloxi Bay), Miss., examination of ..... I, 238; II, 1784
Back Cove, Portland, Me., improvement of channel in ..... I, 31, 705
Bagaduce River, Me.:
Examination of south fork of ..... I, 37, 724
Improvement of ..... I, 24, 681
Ballard, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
Baltimore Harbor, Md.:
Defense of ..... I, 8
Examination of South and Middle Branches of Patapsco River ... I, 148; II, 1262
Improvement of ..... I, 145; II, 1243
Improvement of channel to Curtis Bay ..... I, 145; II, 1249
Removal of wreck in ..... I, 147; II, 1262
Bar Harbor, Me., construction of breakwater near ..... I, 23, 676
Barnegat Inlet, Entrance and Harbor, N. J., examination of ..... I, 129; II, 1185
Barnegat Inlet, N. J., removal of wrecks at ..... I, 128; II, 1182
Barren River, Ky., operating and care of lock and dam on ..... I, 330; III, 2609
Bartholomew, Bayou, La. and Ark., improvement of ..... I, 262; III, 2012
Battalion of Engineers ..... I, 18, 649
Batteries ..... I, 4
Bay Ridge Channel, New York Harbor, N. Y., improvement of ..... I, 101, 1053
Beaufort, N. C.:
Examination for breakwater at ..... I, 183; II, 1457
Improvement of harbor at ..... I, 174; II, 1395
Improvement of waterway between New River and ..... I, 175; II, 1397
Improvement of waterway between Newbern and ..... I, 174; II, 1393
Beaufort River, S. C.:
Improvement of ..... I, 189; II, 1524
Wreck in ..... II, 1530
Beaver River, Pa., construction of dam in Ohio River below ..... I, 313; III, 2484
Belfast Harbor, Me., improvement of ..... I, 26, 687
Bellamy River, N. H., improvement of ..... I, 34, 716
Belle River, Mich., at Marine City, examination of ..... I, 388; IV, 2956
Bellevue, Iowa, examination of Mississippi River at ..... I, 288; III, 2254
Bellingham Bay, Wash., examination for preventing shoaling in ..... I, 446; IV, 3468
Berrians Creek, Long Island, N. Y., examination of ..... I, 92, 993
Berwind, Edith (schooner), removal of wreck of ..... I, 166; II, 1344
Big Black River, Miss., improvement of ..... I, 264; III, 2022
Big Hatchee River, Tenn., improvement of ..... I, 269; III, 2052
Big Sandy River:
Construction of bridge at Catlettsburg, Ky., across ..... I, 464
Examination of bar at mouth of, Ky ..... I, 336; III, 2647
Improvement of Levisa Fork of, Ky ..... I, 333; III, 2635
Improvement of Tug Fork of, W. Va. and Ky ..... I, 333; III, 2637
Improvement of, W. Va. and Ky ..... I, 332; III, 2631
Big Sunflower River, Miss., improvement of ..... I, 268; III, 2047
Bills for bridges, examination of ..... I, 20
Biloxi Bay, Miss., examination of ..... I, 238; II, 1784
Biloxi Harbor, Miss., improvement of ..... I, 234; II, 1772
Black, Bayou, La., examination for connecting Bayou Terrebonne with ... I, 251; III, 1845
Black Creek, Fla., reconstruction of bridge across ..... I, 470
Black Lake Harbor, Mich., improvement of ..... I, 371; IV, 2877
Black River Harbor, Ohio, improvement of ..... I, 400; IV, 3072
Black River, La., improvement of ..... I, 261; III, 2002
Black River, Mich.:
Establishment of harbor lines on ..... I, 462; IV, 2958
Improvement of, at Port Huron ..... I, 385; IV, 2938
Improvement of mouth of ..... I, 386; IV, 2940
Black River, Mo. and Ark., improvement of ..... I, 277; III, 2116
Black River, Mo., improvement of ..... I, 277; III, 2117
Black River, N. C., improvement of ..... I, 177; II, 1407
Black Rock Harbor, Conn., improvement of ..... I, 80, 942

Black Walnut Harbor, Md., examination of ..... I, 143; II, 1239
Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, improvement of ..... I, 229; II, 1751
Blaine, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3479
Block Island, R. I.:
Examination of breachway into Salt Pond ..... I, 71, 880
Harbor of refuge at ..... I, 66, 842
Blood River, La., improvement of ..... I, 240; III, 1810
Bluff Creek, Miss., improvement of ..... I, 234; II, 1770
Board of Engineers, The:
Members ..... I, 15
Members, additional duties of ..... I, 16
Personal examinations ..... I, 16
Bœuf River, La., improvement of ..... I, 263; III, 2015
Bogue Chitto, La., improvement of ..... I, 237; II, 1781
Bogue Falia, La., improvement of ..... I, 239; III, 1808
Bogue Sound, N. C., improvement of ..... I, 175; II, 1397
Booth Brothers (schooner), removal of wreck of ..... II, 1183
Boston and Maine Railroad Company, bridges of ..... I, 467
Boston (East) Channel, Mass., examination of ..... I, 53, 793
Boston, Mass.:
Alteration of bridges across Charles River ..... I, 467
Construction of bridge across Fort Point Channel by city of ..... I, 470
Construction of bridge across Mystic River at ..... I, 469
Defense of ..... I, 5
Improvement of harbor of ..... I, 46, 763
Boyds Ferry, Tenn., construction of bridge across Holston River near ..... I, 470
Brazos River, Tex., examination of ..... I, 257; III, 1893
Brazos Santiago Harbor, Tex., improvement of ..... I, 257; III, 1890
Breakwater construction in Lake Champlain, etc ..... I, 419; IV, 3202
Breakwaters built by the United States, occupancy or injury of ..... I, 20, 475; VI, 4267
Bridgeport Harbor, Conn.:
Establishment of harbor lines in ..... I, 461, 998
Improvement of ..... I, 80, 937
Bridges:
Construction of, across navigable waters ..... I, 20, 463
Examination of bills of Congress for ..... I, 20
Examination of plans and locations of proposed ..... I, 20, 463
Obstructing navigation, action upon ..... I, 20, 473
Brigantine Shoal, N. J., removal of wreck on ..... II, 1183
Broad Creek River, Del., improvement of ..... I, 140; II, 1220
Broadkiln River, Del.:
Examination for waterway to connect Mispillion River with ..... I, 143; II, 1231
Improvement of ..... I, 133; II, 1203
Bronx River, N. Y.:
Reconstruction of bridge across, below West Farms ..... I, 469
Removal of wreck in ..... I, 105, 1076
Brooklyn, N. Y., construction of bridges across East River ..... I, 467
Browneys Island, Me., removal of wreck off ..... I, 37, 722
Browns Creek, Sayville, N. Y., improvement of ..... I, 91, 986
Brunswick Harbor, Ga., improvement of ..... I, 196; II, 1578
Brunswick Outer Bar, Ga., improvement of ..... I, 196; II, 1584
Buckhannon River, W. Va., improvement of ..... I, 335; III, 2644
Buffalo Bayou, Tex.:
Bridge obstructing navigation near Houston, alteration of ..... I, 473
Improvement of ..... I, 256; III, 1886
Buffalo, N. Y.:
Improvement of channels connecting Great Lakes between Chicago, Duluth, and ..... I, 389; IV, 2962
Improvement of harbor of ..... I, 406; IV, 3107
Occupancy of north pier ..... VI, 4272
Burlington Harbor, Vt., improvement of ..... I, 417; IV, 3196
Butte City, Cal., construction of bridge across Sacramento River at ..... I, 467
Buttermilk Channel, New York Harbor, N. Y., improvement of ..... I, 100, 1050

C.

Cache River, Ark., improvement of ..... I, 276; III, 2114
Cahaba River, Ala., improvement of ..... I, 226; II, 1735
Calcasieu River, La., improvement of mouth and passes of ..... I, 217; III, 1830

California:
Department of, report of engineer officer ..... I, 488; VI, 4403
Hydraulic mining and mining débris in ..... I, 460
California Débris Commission ..... I, 460
Caloosahatchee River, Fla., improvement of ..... I, 205; II, 1660
Calumet Harbor, Ill., improvement of ..... I, 361; IV, 2810
Calumet Harbor, Wis., examination of ..... I, 359; IV, 2783
Calumet River, Ill. and Ind.:
Examination for outer harbor at mouth of ..... I, 366; IV, 2846
Improvement of ..... I, 361; IV, 2815
Cambridge Harbor, Md., improvement of ..... I, 139; II, 1218
Cambridge, Mass., alteration of bridges across Charles River ..... I, 467
Camden Harbor, Me., improvement of ..... I, 27, 689
Camden Harbor, N. J., improvement of ..... I, 121; II, 1152
Canals, etc.:
Allegheny River, construction of Herr Island Dam, Pa ..... I, 316; III, 2501
Allegheny River, examination for lock and dam at Tarentum, Pa. I, 319; III, 2538
Allegheny River, examination for lock and dam between Herr Island Dam and Tarentum, Pa ..... I, 319; III, 2535
Cascades Canal, Columbia River, Oregon, construction of ..... I, 450; IV, 3506
Columbia River, between Three Mile Rapids and Celilo Falls, examination for canal ..... I, 458
Coosa River, Ga. and Ala., operating and care of locks and dams on. I, 226; II, 1734
Davis Island Dam, Ohio River, Pa., operating and care of ..... I, 312; III, 2481
Des Moines Rapids Canal and Dry Dock, operating and care of. I, 287; III, 2241
Fox River, Wis., operating and care of locks and dams on ..... I, 358; IV, 2766
Great Kanawha River, W. Va., operating and care of locks and dams on ..... I, 326; III, 2594
Green and Barren rivers, Ky., operating and care of locks and dams on ..... I, 330; III, 2609
Green River, Ky., reconstruction of Lock No. 2 ..... I, 329; III, 2606
Illinois and Mississippi Canal, Ill., construction of ..... I, 364; IV, 2832
Illinois River, Ill., operating and care of La Grange Lock and Dam ..... I, 364; IV, 2830
Kentucky River, Ky., operating and care of locks and dams on. I, 332; III, 2622
Keweenaw Bay to Lake Superior, via Portage Lake and River, Mich., improvement and operating and care of waterway from ..... I, 341, 342; IV, 2680
Licking River, Ky., examination for slackwater navigation on. I, 335; III, 2644
Little Kanawha River, W. Va., operating and care of lock and dam on ..... I, 335; III, 2642
Louisville and Portland Canal, Ky., Ohio River, operating and care of ..... I, 322; III, 2554
Monongahela River, operating and care of locks and dams Nos. 8 and 9 ..... I, 314; III, 2492
Monongahela River, purchase of Lock and Dam No. 6 ..... I, 314; III, 2496
Monongahela River, purchase of Lock and Dam No. 7 ..... I, 314; III, 2495
Muscle Shoals Canal, operating and care of ..... I, 310; III, 2431
Muskingum River, Ohio, operating and care of locks and dams on. I, 317; III, 2506
Ohio River, construction of Beaver River dam in ..... I, 313; III, 2484
Ohio River, examination for location of locks and dams between Davis Island and Beaver River dams ..... I, 319; III, 2533
Ohio River, survey for location of Dam No. 2 ..... I, 313; III, 2486
Rules and regulations and proposed legislation for use of ..... I, 20
Saint Clair Flats Canal, Mich., improvement of ..... I, 392; IV, 3029
Saint Clair Flats Canal, Mich., operating and care of ..... I, 393; IV, 3031
Saint Marys Falls Canal, Mich., operating and care of ..... I, 390; IV, 2970
Sturgeon Bay and Lake Michigan Canal, Wis., construction of harbor of refuge at eastern entrance ..... I, 349; IV, 2719
Sturgeon Bay and Lake Michigan Canal, Wis., improvement of. I, 348; IV, 2714
Sturgeon Bay and Lake Michigan Canal, Wis., operating and care of. I, 349; IV, 2718
Teche Bayou, and Grand Lake at Charenton, La., construction of canal between ..... I, 245
Yamhill River, Oregon, examination for lock and dam at Lafayette. I, 457; IV, 3531
Canapitsit Channel, Mass., improvement of ..... I, 59, 820
Canarsie Bay, N. Y.:
Improvement of ..... I, 106, 1101
Occupancy of dike ..... VI, 4268
Canaveral, Cape, Fla., examination for harbor at ..... I, 211; II, 1681
Cane River at Natchitoches, La., construction of bridge across ..... I, 465
Caney Fork River, Tenn., improvement of ..... I, 306; III, 2402

Cape Ann, Mass., improvement of harbor of refuge at Sandy Bay ..... I, 41, 748
Cape Canaveral, Fla., examination for harbor at ..... I, 211; II, 1681
Cape Charles City Harbor, Va., and approaches, improvement of ..... I, 142; II, 1227
Cape Charles, Va., removal of wrecks near ..... I, 166; II, 1344
Cape Fear (North East) River, N. C., improvement of ..... I, 177; II, 1403
Cape Fear River, N. C.:
Above Wilmington, improvement of ..... I, 178; II, 1411
At and below Wilmington, improvement of ..... I, 179; II, 1419
Removal of wreck at mouth of ..... I, 183; II, 1450
Carver Harbor, Me., examination of ..... I, 37, 725
Cascades Canal, Columbia River, Oregon:
Construction of ..... I, 450; IV, 3506
Portage Railroad on public land ..... VI, 4273
Casemates, mining ..... I, 10
Cassity Bayou, Miss., examination of ..... I, 272; III, 2095
Catlettsburg, Ky., construction of bridge across Big Sandy River at ..... I, 464
Cedar Bayou, Tex., improvement of ..... I, 256; III, 1883
Cedar Creek, Del., examination of ..... I, 143; II, 1231
Cedar Keys Harbor, Fla., improvement of ..... I, 209; II, 1676
Cedar Point, Ala., construction of trestle and bridges across shoal water between Dauphin Island and ..... I, 465
Cedar River Harbor, Mich., improvement of ..... I, 345; IV, 2701
Celilo Falls, Columbia River, examination for overcoming obstructions at ..... I, 458
Champlain, Lake:
Breakwater construction in ..... I, 419; IV, 3202
Construction of breakwater at Rouse Point, N. Y ..... I, 416; IV, 3192
Examination of North Hero Harbor, Vt ..... I, 419; IV, 3213
Improvement of Narrows of, N. Y. and Vt ..... I, 418; IV, 3201
Charenton, La., construction of canal between Bayou Teche and Grand Lake at ..... I, 245
Charles River, Mass.:
Alteration of bridges across ..... I, 467
Improvement of ..... I, 46, 767
Charleston Harbor, S. C.:
Construction of bridge across cove at Sullivans Island ..... I, 469
Defense of ..... I, 4, 9
Improvement of ..... I, 187; II, 1495
Removal of wreck in ..... I, 189; II, 1531
Charlevoix Harbor, Mich., improvement of ..... I, 378; IV, 2908
Charlotte Harbor, Fla., improvement of ..... I, 206; II, 1663
Charlotte Harbor, N. Y., improvement of ..... I, 409; IV, 3132
Chatham Bay, Mass, removal of wrecks in ..... I, 69, 849, 850
Chatham Harbor, Mass., improvement of ..... I, 52, 786
Chattahoochee River, Ga. and Ala., improvement of ..... I, 215; II, 1698
Cheat River, Pa., construction of bridge at Point Marion across ..... I, 466
Cheat River, W. Va., improvement of ..... I, 315; III, 2496
Cheboygan Harbor, Mich., improvement of ..... I, 380; IV, 2917
Chefuncte River, La., improvement of ..... I, 239; III, 1808
Chehalis River, Wash.:
Improvement of, from Claquato to the mouth ..... I, 442; IV, 3414
Improvement of Grays Harbor and ..... I, 442; IV, 3408
Chelsea River, Mass., examination of ..... I, 52, 790
Chenton Inlet, Va. *See* Cherrystone Inlet.
Cherrystone (Chenton) Inlet, Va., improvement of approaches to Cape Charles City Harbor by ..... I, 142; II, 1227
Chesapeake and Ohio Railway Company, bridges of ..... I, 464, 467
Chesapeake Bay, removal of wrecks on the Horseshoe and near Cape Charles ..... I, 166; II, 1344
Chester River, Md., between Crumpton and Jones Landing, improvement of ..... I, 136; II, 1211
Chetco River, Oregon, examination of ..... I, 444; IV, 3429
Chicago and Northern Pacific Railroad Company, bridge of ..... I, 467
Chicago and West Michigan Railway Company, bridge of ..... I, 471
Chicago, Ill.:
Alteration of bridge across South Branch of Chicago River ..... I, 472
Construction of bridge across South Branch of Chicago River by city of ..... I, 467
Construction of bridge across west fork of South Branch of Chicago River ..... I, 467

Chicago, Ill.—Continued.
Improvement of channels connecting Great Lakes between Duluth, Buffalo, and ..... I, 389; IV, 2962
Improvement of harbor of ..... I, 359; IV, 2791
Resurvey of lake front at ..... I, 484; VI, 4372
Chicago River, Ill.:
Alteration of bridge across South Branch of ..... I, 472
Construction of bridge across South Branch of ..... I, 467
Construction of bridge across west fork of South Branch of ..... I, 467
Improvement of ..... I, 359; IV, 2794
Chickahominy River, Va., improvement of ..... I, 162; II, 1331
Chickasahay River, Miss., improvement of ..... I, 233; II, 1769
Chief of Engineers, office of the ..... I, 490
Chincoteague Bay, Va., improvement of waterway between Delaware Bay near Lewes and ..... I, 133; II, 1203
Chipola River, Fla., improvement of lower ..... I, 212; II, 1692
Chippewa River, Wis.:
Improvement of ..... I, 290; III, 2272
Reservoirs at sources of, surveys for ..... III, 2288
Chitto, Bogue, La., improvement of ..... I, 237; II, 1781
Choctawhatchee Bay, Fla.:
Examination of bar at junction of Santa Rosa Sound and ..... I, 228; II, 1742
Examination of bar at mouth of Alaqua Bayou ..... I, 228; II, 1738
Choctawhatchee River, Fla. and Ala., improvement of ..... I, 218; II, 1706
Choptank River, Md., improvement of ..... I, 137; II, 1213
Cincinnati, Ohio:
Alteration of bridge across Ohio River at ..... I, 464
Examination for ice harbors at mouths of Crawfish and Mill creeks ..... I, 320
Examination of Ohio River near ..... I, 318; III, 2523
Cincinnati, Wabash and Michigan Railroad Company, use of wing dam at St. Joseph Harbor, Mich., by ..... VI, 4270
City of Long Branch (steamer), removal of wreck of ..... I, 183; II, 1450
Clark River, S. C., improvement of ..... I, 185; II, 1477
Cleveland Harbor, Ohio, improvement of ..... I, 400; IV, 3075
Clinch River, Tenn., improvement of ..... I, 303; III, 2387
Clinton Harbor, Conn., improvement of ..... I, 76, 917
Clinton River, Mich., improvement of ..... I, 386; IV, 2942
Clubfoot River, N. C., improvement of ..... I, 174; II, 1393
Coaster Harbor Island, R. I., improvement of cove and waterway near ..... I, 63, 835
Cocheco River, N. H., improvement of ..... I, 35, 717
Coldwater River, Miss., examination of ..... I, 272; III, 2099
Coleman, I. D. (steamer), removal of wreck of ..... I, 183; II, 1449
Colorado River, at Yuma, Ariz., improvement of ..... I, 424; IV, 3234
Columbia, Department of the, report of engineer officer ..... I, 488; VI, 4402
Columbia River, Oregon and Wash.:
Bridge across, between Douglas and Kittitas counties, Wash., construction of ..... I, 464
Cascades Canal, construction of ..... I, 450; IV, 3506
Establishment of harbor lines at Flavel, Oregon ..... I, 463; IV, 3537
Examination for overcoming obstructions between Three Mile Rapids and Celilo Falls ..... I, 458
Examination of, from international boundary to Rock Island Rapids ..... I, 445; IV, 3452
Gauging ..... I, 457; IV, 3528
Improvement of, between head of Rock Island Rapids and foot of Priest Rapids ..... I, 439; IV, 3378
Improvement of, between Vancouver, Wash., and mouth of Willamette River ..... I, 449; IV, 3503
Improvement of mouth of ..... I, 447; IV, 3488
Improvement of upper river ..... I, 438; IV, 3375
Improvement of Willamette and, below Portland, Oregon ..... I, 452; IV, 3515
Survey of, from international boundary to Rock Island Rapids ..... I, 440; IV, 3381
Columbiana, Ill., construction of bridge across Illinois River at ..... I, 465
Compton Creek, N. J., improvement of ..... I, 116, 1128
Concord (steamer), removal of wreck of ..... I, 183; II, 1450
Conecuh River, Ala., improvement of ..... I, 221; II, 1716
Congaree River, S. C., improvement of ..... I, 187; II, 1491
Conneaut Harbor, Ohio, improvement of ..... I, 403; IV, 3089
Connecticut River:
Improvement of ..... I, 73, 906
Improvement of, above Hartford, Conn ..... I, 73, 907
Improvement of, below Hartford, Conn ..... I, 74, 908

Contentnia Creek, N. C., improvement of ..... I, 172; II, 1385
Contingencies, examinations, and surveys of rivers and harbors ..... I, 459
Cooper Creek, N. J.:
Examination of ..... I, 129; II, 1189
Removal of wreck in ..... II, 1183
Cooper River, S. C., removal of wrecks in ..... I, 189; II, 1530
Coos Bay, Oregon, improvement of entrance and harbor at ..... I, 434; IV, 3332
Coos River, Oregon, examination of navigable tide water channels in ... I, 445; IV, 3437
Coosa River, Ga. and Ala.:
Improvement of ..... I, 224; II, 1724
Improvement of, between Rome, Ga., and East Tennessee, Virginia and Georgia Railroad Bridge ..... I, 224; II, 1725
Improvement of, between Wetumpka, Ala., and East Tennessee, Virginia and Georgia Railroad Bridge ..... I, 225; II, 1730
Operating and care of locks and dams on ..... I, 226; II, 1734
Coquille River, Oregon:
Improvement of ..... I, 432; IV, 3324
Improvement of, between Coquille City and Myrtle Point ..... I, 433; IV, 3329
Corney, Bayou, La., improvement of ..... I, 261; III, 2009
Corporations, occupancy or injury of public structures by ..... I, 20, 475; VI, 4267
Corps of Engineers:
Changes during the year ..... I, 3
Distribution of officers ..... I, 3
Laws of Fifty-second Congress, second session, affecting the ..... I, 519
Number of officers ..... I, 3
Officers detached ..... I, 4
Statement of rank and duties of officers ..... I, 491
Cos Cob Harbor, Conn., improvement of ..... I, 84, 958
Cosmopolis, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3480
Council Bluffs, Iowa, construction of bridge between East Omaha, Nebr., and ..... I, 465
Courtableau, Bayou, La., improvement of ..... I, 244; III, 1821
Covington, Ky., examination of Ohio River near ..... I, 3.8; III, 2523
Cow Bayou, Tex., about 6 miles above confluence with Sabine River, construction of bridge across ..... I, 470
Cowesset Bay, R. I., examination of Apponaug Harbor ..... I, 71, 869
Cowlitz River, Wash., improvement of ..... I, 456; IV, 3526
Crawfish Creek, Cincinnati, Ohio, examination for ice harbor at mouth of ..... I, 320
Crescent City Harbor, Cal., examination of ..... I, 432; IV, 3308
Cross-over Light, St. Lawrence River, N. Y., improvement of shoals near ..... I, 415; IV, 3188
Cumberland County, Me., alteration of bridge of, obstructing mouth of Fore River ..... I, 472, 474
Cumberland River:
Improvement of ..... I, 304; III, 2389
Improvement of, above mouth of the Jellico, Ky ..... I, 306; III, 2400
Improvement of, above Nashville, Tenn ..... I, 305; III, 2393
Improvement of, below Nashville, Tenn ..... I, 304; III, 2390
Cumberland Sound, Ga., improvement of ..... I, 197; II, 1593
Current River, Ark., examination of ..... I, 279; III, 2128
Currituck Sound, N. C., improvement of waterway through ..... I, 164; II, 1341
Curtis Bay, Md., improvement of channel to ..... I, 145; II, 1249
Cut-off, Apalachicola River, Fla., improvement of the ..... I, 212; II, 1692
Cuttyhunk Island, Mass., improvement of Canapitsit Channel ..... I, 59, 820
Cypress Bayou and lakes between Jefferson, Tex., and Shreveport, La., survey of ..... I, 271; III, 2065

D.

Dalles of Columbia River, examination for overcoming obstructions at ..... I, 458
Dams and locks. *See* Canals.
D'Arbonne, Bayou, La., improvement of ..... I, 261; III, 2009
Darien Harbor, Ga., improvement of ..... I, 193; II, 1556
Dauphin Island, Ala., construction of trestle and bridges across shoal water between Cedar Point and ..... I, 465
Davids Island, N. Y., sea wall and embankment at ..... I, 12, 629
Davis Brothers (schooner), removal of wreck of ..... I, 69, 851
Davis Island Dam, Ohio River, Pa., operating and care of ..... I, 312; III, 2481
Delaware Bay:
Construction of pier near Lewes, Del ..... I, 124; II, 1170

Delaware Bay—Continued.
Improvement of ice harbor at head of, Del ..... I, 123; II, 1169
Improvement of waterway between Chincoteague Bay, Va., and, at or near Lewes, Del ..... I, 133; II, 1203
Removal of wrecks off entrance of ..... I, 128; II, 1183
Delaware Breakwater, Del., improvement of ..... I, 125; II, 1172
Delaware River, Pa. and N. J.:
At Camden, N. J., improvement of ..... I, 121; II, 1152
At Philadelphia, Pa., improvement of ..... I, 121; II, 1152
Improvement of ..... I, 119; II, 1142
Removal of wreck at Bridesburg ..... II, 1183
Dennis Creek, N. J., examination of ..... I, 129; II, 1187
Departments, military, explorations and surveys in ..... I, 488; VI, 4401
Depot, Engineer ..... I, 18, 654
Des Moines Rapids Canal and Dry Dock, operating and care of ..... I, 287; III, 2241
Des Moines Rapids, Mississippi River, improvement of ..... I, 286; III, 2240
Detroit, Mich.:
Construction of bridge across Rouge River near ..... I, 468
Establishment of harbor lines at ..... I, 462; IV, 3039
Detroit River, Mich., improvement of ..... I, 393; IV, 3034
Dickinson Bayou, Tex.:
Alteration of bridge obstructing ..... I, 473
Construction of bridge across ..... I, 466
District of Columbia:
Increasing water supply of Washington, D. C. ..... I, 478; VI, 4309
Public buildings and grounds, and Washington Monument ..... I, 480; VI, 4313
Washington aqueduct ..... I, 475; VI, 4275
Division engineers ..... I, 20
Divisions, engineer ..... I, 20
Dow, Mary E. H. G. (schooner), removal of wreck of ..... I, 166; II, 1344
Dry dock, operating and care of, Des Moines Rapids ..... I, 287; III, 2241
Duck Island Harbor, Conn., improvement of ..... I, 76, 914
Duck River, Tenn., examination of ..... I, 307; III, 2406
Duck Trap Harbor, Me., examination of ..... I, 37, 727
Duluth Harbor, Minn., improvement of ..... I, 337; IV, 2657
Duluth, Minn., improvement of channels connecting Great Lakes between Chicago, Buffalo, and ..... I, 389; IV, 2962
Dunkirk Harbor, N. Y.:
Examination for securing 16 feet depth at ..... I, 409; IV, 3119
Improvement of ..... I, 405; IV, 3103
Durhams Estuary, N. C., up to Edwards Mill, examination of ..... I, 183; II, 1454
Dutch Island Harbor, R. I., removal of wreck in ..... I, 69, 851
Dutch Kills Creek, N. Y., reconstruction of bridge across ..... I, 469

E.

Eagle Harbor, Mich., improvement of ..... I, 341; IV, 2679
East Boston Channel, Mass., examination of ..... I, 53, 793
East Chester Creek, N. Y., improvement of ..... I, 86, 965
East Omaha, Nebr., construction of bridge between Council Bluffs, Iowa, and ..... I, 465
East River Bridge Company, bridges of ..... I, 467
East River, N. Y.:
Construction of bridges across ..... I, 467
Improvement of ..... I, 97, 1034
Modification of harbor lines around Rikers Island ..... I, 461, 1085
Modification of harbor lines at Ravenswood, Long Island ..... I, 461, 1090
Eastern Branch of the Potomac. *See* Anacostia River.
Edgartown Harbor, Mass., removal of wreck in ..... I, 70, 857
Edgartown, Marthas Vineyard, Mass., improvement of inner harbor at ..... I, 55, 809
Edisto River, S. C., improvement of ..... I, 189; II, 1517
Edmonds, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3481
Elizabeth, Pa., construction of bridge across Monongahela River at ..... I, 464
Elizabeth River, N. J., improvement of ..... I, 111, 1113
Elizabethtown, Ill., examination of Ohio River at ..... I, 318; III, 2518
Elk River, Md., improvement of ..... I, 135; II, 1207
Elk River, W. Va., improvement of ..... I, 326; III, 2595
Embarras River, Ill., examination of ..... I, 324; III, 2573
Emory River, Tenn., examination of ..... I, 308; III, 2413
Emplacements for guns and mortars ..... I, 4
Engineer depot ..... I, 18, 654

Engineer divisions ..... I, 20
Engineer School, United States ..... I, 18, 649
Engineers, battalion of ..... I, 18, 649
Engineers, Chief of, office of the ..... I, 490
Engineers, Corps of. *See* Corps of Engineers.
Engineers, division ..... I, 20
Engineers, The Board of ..... I, 15
Erie Harbor, Pa.:
  Improvement of ..... I, 404; IV, 3096
  Improvement of Presque Isle Peninsula ..... I, 405; IV, 3101
Erie, Lake:
  See also Northern and Northwestern lakes.
  Seneca Shoal, survey of ..... I, 484
  Water levels ..... I, 486; VI, 4381
Escambia River, Fla., improvement of ..... I, 221; II, 1716
Essex River, Mass., improvement of ..... I, 41, 747
Estimates:
  Engineer depot ..... I, 19
  Examinations, surveys, and contingencies of rivers and harbors ..... I, 459
  Fortifications ..... I, 4, 14
  Mississippi River Commission ..... I, 460
  Missouri River Commission ..... I, 460
  New York Harbor, supervision of ..... I, 459
  Northern and northwestern lakes, charts and surveys of ..... I, 486
  Public buildings and grounds and Washington Monument, Washington, D. C ..... I, 481
  Rivers and harbors ..... I, 19
  Surveys and reconnaissances and publication of maps ..... I, 489
  Washington aqueduct ..... I, 477
  Yellowstone National Park, roads and bridges in ..... I, 488
Evansville, Ind., examination of harbor at ..... I, 318; III, 2520
Everett Harbor, Wash., examination of ..... I, 446; IV, 3464
Examinations, surveys, and contingencies of river and harbors ..... I, 459
Explorations and reconnaissances ..... I, 488; VI, 4401

F.

Fairfield County, Conn., alteration of bridge of, across Housatonic River ..... I, 474
Fairhaven Harbor, Mass., removal of wreck in ..... I, 69, 851
Fairlee Creek, Md., improvement of ..... I, 136; II, 1210
Fairport Harbor, Ohio, improvement of ..... I, 401; IV, 3081
Fallia, Bogue, La., improvement of ..... I, 239; III, 1808
Falls of Ohio River:
  Improvement of ..... I, 320; III, 2543
  Improvement of Indiana Chute ..... I, 321; III, 2549
Fayette County, Pa., construction of bridge across Youghiogheny River in ..... I, 466
Feather River, Cal., improvement of ..... I, 428; IV, 3271
Felix (bark), removal of wreck of ..... II, 1183
Fellows, Bertha J. (schooner), removal of wreck of ..... I, 69, 850
Fernandina, Fla., improvement of inside waterway between Savannah, Ga., and ..... I, 198; II, 1604
Ferndale, Wash., construction of bridge across Nooksack River at ..... I, 468
Fish, Charlotte (schooner), removal of wreck of ..... I, 69, 855
Fishing Creek, N. C., improvement of ..... I, 170; II, 1377
Fishways at Great Falls, Potomac River, erection of ..... I, 479, ; VI, 4310
Five Mile River Harbor, Conn., improvement of ..... I, 83, 952
Flavel, Oregon, establishment of harbor lines in Columbia River at ..I, 463; IV, 3537
Flint River, Ga., improvement of ..... I, 213, II, 1695
Florida Central and Peninsular Railroad Company, bridges of ..... I, 464, 468
Florida (steamer), removal of wreck of ..... I, 128; II, 1182
Flushing Bay, N. Y., improvement of ..... I, 89, 980
Fore River, Portland, Me., alteration of bridge obstructing mouth of ..... I, 472, 474
Forked Deer River, Tenn., improvement of ..... I, 269; III, 2054
Fort Norfolk, Va., improvement of approach to Norfolk Harbor between Lambert Point and ..... I, 160; II, 1328
Fort (old) Bayou, Miss., examination of channel at mouth of ..... I, 238; II, 1787
Fort Point Channel, Boston, Mass., construction of bridge across ..... I, 470
Fort Pond Bay, N. Y., examination of ..... I, 105, 1077

Fortifications:
Allotments ..... I, 5
Estimates ..... I, 4, 14
Projects ..... I, 4
Sites for, acquisition of ..... I, 10
Fourche Le Fevre River, Ark.:
Examination of ..... I, 279; III, 2125
Improvement of ..... I, 274; III, 2108
Fox River, Wis.:
Examination for construction of protection wall on canal at Kaukauna ..... I, 359; IV, 2779
Examination of mouth of ..... I, 359; IV, 2778
Improvement of ..... I, 357; IV, 2758
Operating and care of locks and dams on ..... I, 358; IV, 2766
Francis Edwards (schooner), removal of wreck of ..... I, 69, 851
Frankford Creek, Philadelphia, construction of bridge across ..... I, 466
Frankfort Harbor, Mich., improvement of ..... I, 378; IV, 2905
Frankfort, Ky.:
Alteration of city bridge across Kentucky River at ..... I, 473
Reconstruction of bridge across Kentucky River at ..... I, 471
Franklin County, Ky., alteration of bridge of, across Kentucky River at Frankfort ..... I, 473
Franklin, La., removal of wreck near ..... I, 250; III, 1839
Freeport, N. Y., examination for channel connecting Great South Bay with ..... I, 118, 1136
French Broad River, Tenn., improvement of ..... I, 301; III, 2383
Frenchs Beach Harbor, Me., examination of ..... I, 37, 728

G.

Galveston Bay, Tex.:
Improvement of ship channel in ..... I, 253; III, 1872
Trespass on and injury to public works ..... VI, 4269
Galveston Harbor, Tex., improvement of entrance to ..... I, 252; III, 1861
Galveston, Houston and Henderson Railroad Company, bridge of ..... I, 473
Garwood Ferry, Cal., construction of bridge across San Joaquin River at ..... I, 467
Gasconade River, Mo., improvement of ..... I, 283; III, 2178
Gaskill, Annie S. (schooner), removal of wreck of ..... I, 128; II, 1183
Gaudaloup (steamer), removal of wreck of ..... I, 128; II, 1182
Gauging:
Columbia River, Oregon and Wash ..... I, 457; IV, 3528
Mississippi River and its principal tributaries ..... I, 269; III, 2057
Mississippi River at St. Paul, Minn ..... I, 294; III, 2289
Gauley River, W. Va.:
Construction of bridge across ..... I, 467
Improvement of ..... I, 327; III, 2598
Geestemunde (ship), removal of wreck of ..... I, 128; II, 1182
Georges River, Me., examination of ..... I, 38, 734
Georgetown Harbor, S. C., improvement of ..... I, 181; II, 1437
Gila River, at Yuma, Ariz., improvement of ..... I, 424; IV, 3234
Glen Cove Harbor, N. Y., improvement of ..... I, 89, 978
Glenn County, Cal., construction of bridge across Sacramento River by ..... I, 467
Gloucester Harbor, Mass.:
Examination of, from Five Pound Island to head of river ..... I, 52, 787
Examination of Vincent Cove ..... I, 52, 788
Improvement of ..... I, 42, 751
Golden Gate, Cal., examination of ..... I, 420; IV, 3221
Goodyear, C. P., improvement of outer bar at Brunswick, Ga., by ..... I, 196; II, 1584
Goshen Creek, N. J., improvement of ..... I, 128; II, 1180
Governors Island, N. Y., sea walls at ..... I, 13, 631
Gowanus Bay, New York Harbor, N. Y., improvement of ..... I, 101, 1053
Gowanus Creek Channel, New York Harbor, N. Y., improvement of ..... I, 101, 1053
Grand Haven Harbor, Mich., improvement of ..... I, 372; IV, 2879
Grand Isle, Vt., examination of harbor at Adams (Tobias) Landing ..... I, 419; IV, 3215
Grand Lake, La.:
Construction of canal between Bayou Teche and ..... I, 245
Improvement of ..... I, 246; III, 1828
Grand Marais, Mich., improvement of harbor of refuge at ..... I, 343; IV, 2689
Grand Marais, Minn., improvement of harbor at ..... I, 336; IV, 2651
Grand River, La., improvement of ..... I, 243; III, 1818
Grand River, Ohio. *See* Fairport Harbor.

Grant, General (canal boat), removal of wreck of.....II, 1183
Grays Harbor, Wash., improvement of.....I, 442; IV, 3408
Grayson, Cal., construction of bridge across San Joaquin River at.....I, 466
Great Chazy River, N. Y., improvement of.....I, 416; IV, 3194
Great Choptank River, Md., examination of Black Walnut Harbor at mouth of.....I, 143; II, 1239
Great Egg Harbor Inlet, N. J., removal of wreck at.....I, 128; II, 1182
Great Falls, Potomac River, erection of fishways at.....I, 479; VI, 4310
Great Kanawha River, W. Va.:
Improvement of.....I, 324; III, 2577
Operating and care of locks and dams on.....I, 326; III, 2594
Great Lakes:
See also Northern and Northwestern Lakes.
Breakwater construction in.....I, 419; IV, 3202
Improvement of channels connecting.....I, 389; IV, 2962
Investigation of raft-towing on.....I, 394
Great Pedee River, S. C., improvement of.....I, 185; II, 1474
Great Sodus Bay, N. Y., improvement of harbor at.....I, 411; IV, 3140
Great South Bay, N. Y., examination for channel connecting Freeport with.....I, 118, 1136
Green Bay Harbor, Wis., improvement of.....I, 347; IV, 2711
Green Bay, Wis., from light-house to first bridge on Fox River, examination of.....I, 359; IV, 2778
Green Jacket Shoal, Providence River, R. I., removal of.....I, 62, 832
Green River, Ky.:
Improvement of, above mouth of Big Barren River.....I, 329; III, 2608
Operating and care of locks and dams on.....I, 330; III, 2609
Reconstruction of Lock No. 2, at Rumsey.....I, 329; III, 2606
Trespass on public land at Lock No. 3.....VI, 4270
Greenport Harbor, N. Y., improvement of.....I, 87, 969
Greenwich Bay, R. I., improvement of.....I, 63, 834
Greenwich Harbor, Greenwich Bay, R. I., examination of.....I, 71, 871
Grossepoint Channel, Mich., improvement of.....I, 393; IV, 3034
Gun emplacements.....I, 4
Guyandotte River, W. Va., improvement of.....I, 334; III, 2639

H.

Hackensack River, N. J., construction of bridge across.....I, 466
Hamburg Bay, Ill., on Mississippi River, examination of.....I, 287; III, 2248
Hammond Bay, Mich., examination of.....I, 388; IV, 2948
Hampton Roads, Va., defense of.....I, 5, 9
Handkerchief Shoal, Mass., removal of wrecks at.....I, 69, 70, 854, 859
Handsboro, Miss., examination of Biloxi Bay up to.....I, 238; II, 1784
Harbor and river improvements.....I, 19
Harbor lines, establishment of.....I, 20, 461
Allouez Bay, Wis.....I, 462; IV, 2695
Black River at Port Huron, Mich.....I, 462; IV, 2958
Bridgeport Harbor, Conn.....I, 461, 998
Columbia River at Flavel, Oregon.....I, 463; IV, 3537
Detroit, Mich.....I, 462; IV, 3039
Milwaukee River, Milwaukee, Wis.....I, 462; IV, 2788
New York Harbor and adjacent waters.....I, 461, 1085
Oconto Harbor, Wis.....I, 462, IV, 2784
Oswego, N. Y.....I, 462; IV, 3178
Saint Marys River at Sault Ste. Marie, Mich.....I, 462; IV, 3037
Savannah River, near quarantine station at Savannah, Ga.....I, 462; II, 1610
Shaws Cove, New London Harbor, Conn.....I, 461, 997
Washington, ports in State of.....I, 462; IV, 3472
Harbors and rivers, examinations, surveys, and contingencies of.....I, 459
Hardys Point, Me., examination of channel near, below Pembroke.....I, 37, 722
Harlem River and Portchester Railroad Company, bridge of.....I, 469
Harlem River, N. Y.:
Improvement of.....I, 95, 1025
Reconstruction of bridge across, at Broadway crossing, New York.....I, 467
Reconstruction of bridge at Third avenue, New York, across.....I, 469
Harlowe River, N. C., improvement of.....I, 174; II, 1393
Harrasceket River, Me., improvement of.....I, 30, 699
Havre de Grace, Md., improvement of Susquehanna River near.....I, 134; II, 1205
Hay Lake Channel, St. Marys River, Mich., improvement of.....I, 388; IV, 2948

Hell Gate, N. Y., improvement of ..... I, 97, 1034
Hempstead Bay, N. Y., examination for channel connecting Freeport with Great South Bay ..... I, 118, 1136
Henry, Francis J. (canal boat), removal of wreck of ..... II, 1183
Herr Island Dam, Allegheny River, Pa., construction of ..... I, 316; III, 2501
Hingham Harbor, Mass., improvement of ..... I, 48, 774
Hiwassee River, Tenn.:
Examination of ..... I, 307; III, 2412
Improvement of ..... I, 301; III, 2381
Holland Harbor, Mich., improvement of ..... I, 371; IV, 2877
Holmes River, Fla., improvement of ..... I, 217; II, 1705
Holston River near Knoxville (Boyds Ferry), Tenn., construction of bridge across ..... I, 470
Homestead and Pittsburgh Bridge Company, bridge of ..... I, 465
Homestead, Pa., construction of bridge across Monongahela River at ..... I, 465
Homochitto River, Miss., examination of ..... I, 251; III, 1839
Hoquiam, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
Housatonic River, Conn.:
Bridge obstructing navigation between Stratford and Milford, alteration of ..... I, 474
Improvement of ..... I, 79, 932
Houston, Tex.:
Alteration of bridge obstructing Buffalo Bayou near ..... I, 473
Construction of bridge across White Oak Bayou at ..... I, 466
Hudson River, N. Y., improvement of ..... I, 92, 1006
Huger, B. F. (tug), removal of wreck of ..... II, 1530
Humboldt Harbor and Bay, Cal., improvement of ..... I, 429; IV, 3278
Huntington Harbor, N. Y., improvement of ..... I, 88, 975
Huntress (schooner), removal of wreck of ..... I, 37, 722
Huron Harbor, Ohio, improvement of ..... I, 398; IV, 3067
Huron, Lake:
See also Northern and Northwestern Lakes.
Improvement of harbor of refuge at Sand Beach, Mich ..... I, 384; IV, 2931
Water levels ..... IV, 2995; VI, 4381
Hyannis, Mass., improvement of harbor of refuge at ..... I, 53, 804
Hydraulic mining in California ..... I, 460

I.

Illinois and Mississippi Canal, Ill., construction of ..... I, 364; IV, 2832
Illinois River, Ill.:
Construction of bridge at Columbiana across ..... I, 465
Improvement of ..... I, 362; IV, 2822
Operating and care of La Grange Lock and Dam ..... I, 364; IV, 2830
Ilwaco, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3481
Indian River, Fla., between Goat Creek and Jupiter Inlet, improvement of ..... I, 203; II, 1656
Indiana Chute, Falls of Ohio River, improvement of ..... I, 321; III, 2549
Individuals, occupancy or injury of public structures by ..... I, 20, 475; VI, 4267
Injury to structures built by United States ..... I, 20, 475; VI, 4267
Inland waterways. *See* Waterways.
Inside routes, waterways, etc. *See* Waterways.
Interstate Bridge and Street Railway Company, bridge of ..... I, 465
Ipswich River, Mass., improvement of ..... I, 40, 746
Isabel Alberto (schooner), removal of wreck of ..... I, 37, 722

J.

Jackson, Miss., examination for diversion of Pearl River through Tan Yard Branch, near ..... I, 238; II, 1792
Jacksonville, St. Augustine and Indian River Railway Company, bridges of ..... I, 471
Jacksonville, Tampa and Key West Railway Company, bridges of ..... I, 469, 470
Jamaica Bay, N. Y., improvement of ..... I, 103, 1069
James River, S. Dak., examination of ..... I, 297; III, 2321
James River, Va., improvement of ..... I, 145; II, 1251
Jeannerette, La., removal of wreck near ..... I, 250; III, 1839
Jefferson, Tex., survey of lakes between Shreveport, La., and ..... I, 271; III, 2065
Jekyl Creek, Ga., improvement of ..... I, 197; II, 1590
Johnsonville, Tenn., alteration of bridge across Tennessee River at ..... I, 472
Jordan River, Miss., examination of bar at mouth of ..... I, 238; II, 1789
Judith, Point, Breakwater, R. I., examination of inner harbor at ..... I, 71, 877

Judith, Point, Pond, R. I., improvement of entrance to ..... I, 66, 841
Judith, Point, R. I., construction of harbor of refuge at ..... I, 65, 839
Jupiter River, Fla., construction of bridge across ..... I, 471

K.

Kansas River, Kans., examination of ..... I, 294; III, 2293
Kaskaskia River, Ill., improvement of ..... I, 284; III, 2185
Kaukauna, Wis., examination for construction of protection wall on canal at ..... I, 359; IV, 2779
Kennebec River, Me., improvement of ..... I, 28, 693
Kennebunk River, Me., improvement of ..... I, 33, 712
Kenosha Harbor, Wis., improvement of ..... I, 355; IV, 2751
Kentucky River, Ky.:
Bridge at Frankfort across, reconstruction of ..... I, 471
Bridge of Frankfort City and Franklin County across, alteration of ..... I, 473
Improvement of ..... I, 331; III, 2618
Operating and care of locks and dams on ..... I, 332; III, 2622
Kewaunee Harbor, Wis., improvement of ..... I, 350; IV, 2724
Kewaunee River, Wis., construction of bridge at Kewaunee, across ..... I, 466
Kewaunee, Wis., construction of bridge across Kewaunee River by city of ..... I, 466
Keweenaw Bay, waterway from Lake Superior to, via Portage Lake and River, Mich.:
Improvement of ..... I, 341; IV, 2680
Operating and care of ..... I, 342; IV, 2680
Keweenaw Point, Mich., waterway across:
Improvement of ..... I, 341; IV, 2680
Operating and care of ..... I, 342; IV, 2680
Key West Harbor, Fla., improvement of northwest entrance of ..... I, 204; II, 1657
Keyport Harbor, N. J., improvement of ..... I, 114, 1123
Kings Coulee, Minn., examination for harbor of refuge at ..... I, 288; III, 2257
Kingston Harbor, Mass., improvement of ..... I, 50, 781
Kinnickinnic River, Milwaukee, Wis., construction of bridge across ..... I, 470
Klaskuine River, Oregon, improvement of ..... I, 456; IV, 3527
Knox County, Tenn., construction of bridge across Holston River by ..... I, 470
Knoxville Southern Railroad Company, bridge of ..... I, 463
Knoxville, Tenn.:
Construction of bridge across Holston River near ..... I, 470
Construction of bridge across Tennessee River at ..... I, 463
Kootenai River, Idaho, between Fry and international boundary line, examination of ..... I, 446; IV, 3456

L.

Labadieville Bridge Company, bridge of ..... I, 470
Labadieville, La., construction of bridge across Bayou Lafourche, at ..... I, 470
La Conner, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
Lafayette, Oregon, examination for lock and dam on Yamhill River at ..... I, 457; IV, 3531
Lafourche, Bayou, La.:
Bridge at Labadieville, La., across, construction of ..... I, 470
Bridge at Napoleonville, across, construction of ..... I, 470
Improvement of ..... I, 242; III, 1814
La Grange Bayou, Fla., improvement of ..... I, 217; II, 1705
La Grange Lock and Dam, Illinois River, Ill., operating and care of ..... I, 361; IV, 2830
Lake Shore and Michigan Southern Railway Company, bridge of ..... I, 466
Lakes, Great. *See* Great Lakes *and* Northern and Northwestern Lakes.
Lakes, Northern and Northwestern. *See* Northern and Northwestern Lakes *and* Great Lakes.
Lambert Point, Va., improvement of approach to Norfolk Harbor between Fort Norfolk and ..... I, 160; II, 1328
Larchmont Harbor, N. Y., improvement of ..... I, 85; 963
La Trappe River, Md., improvement of ..... I, 138; II, 1215
Laws of Fifty-second Congress, second session, affecting Corps of Engineers ..... I, 519
Lea, Charles (tug), removal of wreck of ..... I, 143; II, 1228
Leaf River, Miss., improvement of ..... I, 234; II, 1771
Legislation proposed concerning use of canals ..... I, 20
Levisa Fork of Big Sandy River, Ky., improvement of ..... I, 333; III, 2635
Lewes, Del.:
Construction of pier near ..... I, 124; II, 1170
Improvement of waterway between Chincoteague Bay, Va., and Delaware Bay, at or near ..... I, 133; II, 1208

Lewis, Marcia S. (schooner), removal of wreck of.....I, 128; II, 1182
Lewis River, Wash., examination of.....I, 458; IV, 3533
Licking River, Ky.:
Examination for providing slack-water navigation on.....I, 335; III, 2644
Improvement of, between Farmers and West Liberty.....I, 332; III, 2630
Lincolnville Harbor, Me., examination of.....I, 37, 727
Litchfield, Carrollton and Western Railroad Company, bridge of.....I, 465
Little Harbor, N. H., improvement of harbor of refuge at.....I, 36, 719
Little Kanawha River, W. Va.:
Improvement of.....I, 334; III, 2641
Operating and care of lock and dam on.....I, 335; III, 2642
Little Miami River, Ohio, examination of, for ice harbor.....I, 318; III, 2525
Little Pedee River, S. C., improvement of.....I, 185; II, 1471
Little Pigeon River, Tenn., improvement of.....I, 302; III, 2383
Little Red River, Ark., improvement of.....I, 276; III, 2115
Little River, Ark., examination of.....I, 271; III, 2087
Little River, Mo., improvement of.....I, 279; III, 2121
Little Sodus Bay, N. Y., improvement of harbor at.....I, 412; IV, 3146
Little Wabash River, Ill., examination of.....I, 324; III, 2569
Little Wicomico River, Va., examination of mouth of.....I, 158; II, 1315
Livingston Point, Ky.:
Examination of Ohio River between Tennessee Island and.....I, 307; III, 2404
Improvement of.....I, 300; III, 2377
Locks and dams. *See* Canals.
Lockwoods Folly River, N. C., improvement of.....I, 180; II, 1432
Long Island City, N. Y., reconstruction of bridge across Dutch Kills Creek at.....I, 469
Long Island Railroad Company, bridge of.....I, 469
Louisville and Nashville Railroad Company, bridge of.....I, 471
Louisville and Portland Canal, Ky., operating and care of.....I, 322; III, 2554
Louisville, Ky., improvement of Falls of Ohio River at.....I, 320; III, 2543
Louisville, St. Louis and Texas Railway Company, bridge of.....I, 469
Lowell, Wash., examination of Snohomish River below.....I, 446; IV, 3462
Lower Machodoc Creek, Va., improvement of.....I, 152; II, 1289
Lubec Channel, Me., improvement of.....I, 22, 671
Ludington Harbor, Mich., improvement of.....I, 375; IV, 2895
Ludlow, Ky., examination of Ohio River near.....I, 318; III, 2523
Lulu (schooner), removal of wreck of.....I, 166; II, 1344
Lumber River, N. C. and S. C.:
Construction of bridge across.....I, 467
Improvement of.....I, 184; II, 1468
Lumberman (schooner), removal of wreck of.....I, 358; IV, 2777
Lynch River, S. C., examination of.....I, 190; II, 1532
Lynn and Boston Railroad Company, bridge of.....I, 469
Lynn Harbor, Mass., improvement of.....I, 44, 758

M.

McClellan (barge), removal of wreck of.....I, 128; II, 1183
McGirts Creek, Fla., reconstruction of bridge across.....I, 470
Machodoc (Lower) Creek, Va., improvement of.....I, 152; II, 1289
Mackeys Creek, N. C., improvement of.....I, 169; II, 1357
Maçon, Bayou, La., improvement of.....I, 263; III, 2018
Malden River, Mass., improvement of.....I, 45, 762
Manasquan River, N. J., improvement of.....I, 118, 1133
Manatee River, Fla., improvement of.....I, 207; II, 1668
Manchac, Bayou, La., improvement of.....I, 241; III, 1812
Manchester and Augusta Railroad Company, bridge of.....I, 470
Manchester Harbor, Mass., improvement of.....I, 43, 754
Manistee Harbor, Mich., improvement of.....I, 376; IV, 2897
Manistique Harbor, Mich., improvement of.....I, 344; IV, 2700
Manitowoc Harbor, Wis., improvement of.....I, 352; IV, 2730
Manokin River, Md., improvement of.....I, 141; II, 1223
Maps, military and other.....I, 488
Marcus Hook, Pa., improvement of ice harbor at.....I, 123; II, 1168
Marietta and North Georgia Railway Company, bridge of.....I, 463
Marine City, Mich., examination of Belle River at.....I, 388; IV, 2956
Marquette Harbor, Mich., improvement of.....I, 342; IV, 2686
Marthas Vineyard, Mass., improvement of inner harbor at Edgartown.....I, 55, 809
Marysville, Wash., establishment of harbor lines at.....I, 463; IV, 3475

Mattaponi River, Va., improvement of ..... I, 156; II, 1306
Mattawan Creek, N. J., improvement of ..... I, 115, 1125
Matthews, John (steamer), removal of wreck of ..... I, 279; III, 2121
Maumee River and Bay, Ohio, improvement of ..... I, 395; IV, 3050
Memphis Harbor, Tenn., examination of ..... I, 280; III, 2133
Menominee Harbor, Mich. and Wis., improvement of ..... I, 345; IV, 2703
Menominee River, Mich. and Wis., improvement of ..... I, 346; IV, 2706
Merced River, Cal., examination of ..... I, 431; IV, 3297
Mermentau River, La., and tributaries, improvement of ..... I, 246; III, 1828
Merrimac River, Mass., improvement of ..... I, 39, 742
Mexico Bay, Lake Ontario, N. Y., examination for harbor of refuge at ..... I, 414; IV, 3169
Miamus River, Conn., improvement of ..... I, 84, 958
Michigan City Harbor, Ind., improvement of ..... I, 366; IV, 2858
Michigan, Lake:
See also Northern and Northwestern Lakes.
Dredging harbors on east coast ..... IV, 2913
Examination of Wolf River Harbor, Ind ..... I, 366; IV, 2850
Removal of wreck off Wind Point, Wis ..... I, 358; IV, 2777
Resurvey of lake front at Chicago, Ill ..... I, 484; VI, 4372
Water levels ..... I, 486; VI, 4383
Michigan, Lake, and Sturgeon Bay Canal, Wis.:
Construction of harbor of refuge at eastern entrance of ..... I, 349; IV, 2719
Improvement of ..... I, 348; IV, 2714
Operating and care of ..... I, 349; IV, 2718
Milford, Conn., alteration of bridge obstructing Housatonic River at ..... I, 474
Milford Harbor, Conn., improvement of ..... I, 78, 929
Milford Haven, Va., examination of bar at mouth of ..... I, 158; II, 1319
Military and other maps ..... I, 488
Military departments, surveys and explorations in ..... I, 488; VI, 4401
Mill Creek, Cincinnati, Ohio, examination for ice harbor at mouth of ..... I, 320
Milwaukee Bay, Wis., improvement of harbor of refuge at ..... I, 353; IV, 2741
Milwaukee Harbor, Wis., improvement of ..... I, 354; IV, 2744
Milwaukee River, Wis.:
Construction of bridge across, at Milwaukee ..... I, 469
Establishment of harbor lines at Milwaukee ..... I, 462; IV, 2788
Milwaukee, Wis.:
City bridge across Kinnickinnic River, construction of ..... I, 470
City bridge across North Menomonee Canal, construction of ..... I, 470
Construction of bridge across Milwaukee River by city of ..... I, 469
Establishment of harbor lines in Milwaukee River ..... I, 462; IV, 2788
Mingo Creek, S. C., improvement of ..... I, 186; II, 1480
Mining casemates ..... I, 10
Mining, hydraulic, in California ..... I, 460
Minnesota Point, at Superior, Wis., improvement of ..... I, 339; IV, 2673
Minnesota River, Minn., improvement of ..... I, 292; III, 2278
Mispillion River, Del.:
Examination for waterway to connect Broadkiln River with ..... I, 143; II, 1231
Improvement of ..... I, 132; II, 1201
Removal of wreck in ..... I, 113; II, 1228
Mississippi and Illinois Canal, Ill., construction of ..... I, 361; IV, 2832
Mississippi River:
Bridge above New Orleans, construction of ..... I, 465
Examination for additional harbors of refuge on Lake Pepin ..... I, 288; III, 2257
Examination of, at Bellevue, Iowa ..... I, 288; III, 2254
Examination of Hamburg Bay, Ill ..... I, 287; III, 2248
Examination of harbor at Memphis, Tenn ..... I, 280; III, 2133
Examination of Iowa side of, from Iowa River to Burlington ..... I, 287; III, 2251
Examination of Moline Harbor, Ill ..... I, 288; III, 2253
Gauging, and its principal tributaries ..... I, 269; III, 2057
Gauging, at or near St. Paul, Minn ..... I, 294; III, 2289
Improvement of, above Falls of St. Anthony, Minn ..... I, 288; III, 2261
Improvement of, at St. Louis, Mo ..... I, 282; III, 2177
Improvement of, below mouth of Ohio River ..... I, 459; V, 3545
Improvement of, between Missouri River and Minneapolis ..... I, 285; III, 2206
Improvement of, between Ohio and Missouri rivers ..... I, 281; III, 2140
Improvement of Des Moines Rapids ..... I, 286; III, 2241
Operating and care of Des Moines Rapids Canal and Dry Dock ..... I, 287; III, 2247
Plaquemine, Bayou, La., bank protection at mouth of ..... I, 252; III, 1857
Reservoirs at head waters of ..... I, 289; III, 2264
Reservoirs at sources of, surveys for ..... III, 2288
Snag boats and dredge boats on upper river, operation of ..... I, 285; III, 2189

Mississippi River—Continued.
Snags and wrecks, removal of ..... I, 280; III, 2139
South Pass, inspection of improvement of ..... I, 20, 238; III, 1795
Survey of ..... I, 459; V, 3545
Mississippi River Commission ..... I, 459; V, 3545
Mississippi Sound, Miss., examination of ..... I, 237; II, 1783
Missouri, Department of the, report of engineer officer ..... I, 488; VI, 4401
Missouri, Kansas and Texas Railway Company of Texas, bridge of ..... I, 466
Missouri River:
Bridge at St. Charles, Mo., construction of ..... I, 465
Bridge between Council Bluffs, Iowa, and East Omaha, Nebr., construction of ..... I, 465
Examination of, from Three Forks to Canyon Ferry, Mont., to determine availability of water power ..... I, 297; III, 2320
Improvement of, between Great Falls, Mont., and Sioux City, Iowa ..... I, 295; III, 2297
Improvement of, surveys, etc., below Sioux City, Iowa ..... I, 460; VI, 3921
Removal of snags, etc., above Sioux City, Iowa ..... I, 296; III, 2319
Missouri River Commission ..... I, 460; VI, 3921
Mobile and Dauphin Island Railroad and Harbor Company, trestle and bridges of ..... I, 465
Mobile County, Ala., alteration of bridge of, across Threemile Creek ..... I, 473
Mobile Harbor, Ala., improvement of ..... I, 228; II, 1744
Mobile River, Ala., removal of wreck in ..... I, 237; II, 1782
Mokelumne River, Cal.:
Construction of bridge at New Hope Landing across South Fork of ..... I, 469
Improvement of ..... I, 427; IV, 3269
Moline Harbor, Ill., examination of ..... I, 288; III, 2253
Monomoy, Mass., removal of wrecks near ..... I, 69, 70, 849, 850, 854, 855, 859
Monongahela River, W. Va. and Pa.:
Bridge across, at Elizabeth, Pa., construction of ..... I, 464
Bridge between Pittsburg and Homestead, Pa., construction of ..... I, 465
Improvement of ..... I, 313; III, 2488
Lock and Dam No. 6, purchase of ..... I, 314; III, 2496
Lock and Dam No. 7, purchase of ..... I, 314; III, 2495
Operating and care of locks and dams Nos. 8 and 9 ..... I, 314; III, 2492
Monroe, Fort, Va., water supply and sewerage system at ..... I, 13, 635
Monroe Harbor, Mich., improvement of ..... I, 395; IV, 3047
Moosabec Bar, Me., improvement of ..... I, 22, 673
Morattico Creek, Va., examination of mouth of ..... I, 158; II, 1317
Mortar emplacements ..... I, 4
Mount Desert, Me., construction of breakwater between Porcupine Island and ..... I, 23, 676
Mount Pleasant and Seaview City Railroad Company, bridge of ..... I, 469
Murderkill River, Del., improvement of ..... I, 132; II, 1200
Muscle Shoals Canal, Tennessee River, operating and care of ..... I, 310; III, 2431
Muskegon Harbor, Mich.:
Improvement of ..... I, 373; IV, 2885
Injury to piers ..... VI, 4270, 4271
Muskegon Lake, Mich., construction of bridge across ..... I, 468
Muskegon, Mich., construction of bridge across Muskegon River by city of ..... I, 468
Muskegon River, Mich., construction of bridge across, by city of Muskegon ..... I, 468
Muskingum River, Ohio:
Construction of ice harbor at mouth of ..... I, 316; III, 2502
Improvement of ..... I, 317; III, 2504
Operating and care of locks and dams on ..... I, 317; III, 2506
Mystic River, Conn., improvement of ..... I, 72, 898
Mystic River, Mass.:
Construction of bridge across, at Boston ..... I, 469
Improvement of ..... I, 45, 762

N.

Nansemond River, Va., improvement of ..... I, 161; II, 1329
Nanticoke River, Del., examination of ..... I, 143; II, 1236
Nantucket Harbor, Mass., removal of wreck in ..... I, 70, 856
Nantucket, Mass., improvement of harbor of refuge at ..... I, 54, 806
Nantucket Sound, Mass., removal of wrecks near Monomoy and in Pollock Rip Channel ..... I, 69, 70, 849, 850, 852, 853, 854, 855, 857, 859

Napa River, Cal., improvement of ..... I, 421; IV, 3223
Napoleonville Bridge Stock Company, bridge of ..... I, 470
Napoleonville, La., construction of bridge across Bayou Lafourche at ..... I, 470
Narragansett Bay, R. I.:
Examination of Wickford Harbor ..... I, 71, 873
Defense of ..... I, 4, 6
Improvement of ..... I, 61, 830
Removal of wreck in Dutch Island Harbor ..... I, 69, 851
Narraguagus River, Me., improvement of ..... I, 23, 674
Narrows of Lake Champlain, improvement of ..... I, 418; IV, 3201
Nasel River, Wash., improvement of ..... I, 411; IV, 3399
Nashawena Island, Mass., improvement of Canapitsit Channel ..... I, 59, 820
Nashville, Chattanooga and St. Louis Railway Company, bridge of ..... I, 472
Natalbany River, La., improvement of ..... I, 240; III, 1810
Natchitoches Cane River Bridge Company, bridge of ..... I, 465
Natchitoches, La., construction of bridge across Cane River at ..... I, 465
Naushon Island, Mass., examination for breakwater at Tarpaulin Cove ..... I, 71, 864
Navarro River, Cal., examination of mouth of ..... I, 432; IV, 3304
Navigable waters:
Bridges obstructing, action upon ..... I, 20, 473
Construction of bridges across ..... I, 20, 463
Navigation, action upon bridges obstructing ..... I, 20, 473
Neches River, Tex.:
Examination of ..... I, 251; III, 1853
Improvement of ..... I, 250; III, 1837
Nehalem Bay, Oregon, improvement of entrance to ..... I, 437; IV, 3371
Nemadji River, Wis., examination of ..... I, 344; IV, 2692
Neponset River, Mass., examination of ..... I, 53, 800
Neshawana Island, Mass., improvement of Canapitsit Channel ..... I, 59, 820
Nestugga River, Oregon, as far as Woods, examination of ..... I, 445; IV, 3446
Neuse River, N. C., improvement of ..... I, 173; II, 1390
New Bedford Harbor, Mass.:
Examination of ..... I, 71, 866
Improvement of ..... I, 57, 815
New Castle, Del., improvement of ice harbor at ..... I, 130; II, 1196
New Haven, Conn., construction of breakwaters at ..... I, 77, 924
New Haven County, Conn., alteration of bridge of, obstructing Housatonic River ..... I, 474
New Haven Harbor, Conn., improvement of ..... I, 77, 919
New Hope Landing, Cal., construction of bridge across south fork of Mokelumne River at ..... I, 469
New Kensington, Pa., construction of bridge across Allegheny River at ..... I, 470
New London Harbor, Conn., establishment of harbor lines in Shaws Cove ..... I, 461, 997
New Orleans, La.:
Construction of bridge across Mississippi River above ..... I, 465
Defense of ..... I, 4
New River, N. C.:
Improvement of ..... I, 176; II, 1400
Improvement of waterway between Beaufort Harbor and ..... I, 175; II, 1397
Improvement of waterway between Swansboro and ..... I, 176; II, 1399
New River, Va. and W. Va., improvement of ..... I, 328; III, 2603
New York Harbor, N. Y.:
Davids Island, sea wall and embankment at ..... I, 12, 629
Defense of ..... I, 5, 6, 599
Establishment of harbor lines in, and adjacent waters ..... I, 461, 1085
Examination for channel west of Robbins Reef Light-house to connect mouth of Arthur Kill with ..... I, 105, 1083
Governors Island, sea walls at ..... I, 13, 631
Improvement of ..... I, 102, 1060
Improvement of Arthur Kill ..... I, 108, 1104
Improvement of Bay Ridge Channel ..... I, 101, 1053
Improvement of Buttermilk Channel ..... I, 100, 1050
Improvement of channel between Staten Island and New Jersey ..... I, 108, 1106
Improvement of Gowanus Bay ..... I, 101, 1053
Improvement of Gowanus Creek Channel ..... I, 101, 1053
Improvement of Red Hook Channel ..... I, 101, 1053
Removal of wreck in ..... I, 105, 1076
Supervision of ..... I, 459; IV, 3541

New York, N. Y.:
Bridge across Harlem River at Broadway crossing, reconstruction of, by city ..... I, 467
Bridge across Harlem River at Third avenue, reconstruction of..... I, 469
Bridges across East River, construction of ..... I, 467
Newbern, N. C., improvement of waterway between Beaufort and..... I, 174; II, 1393
Newburyport Harbor, Mass., improvement of ..... I, 38, 739
Newport and Cincinnati Bridge Company, bridge of..... I, 464
Newport Harbor, R. I., improvement of..... I, 64, 836
Newport River, N. C., improvement of..... I, 174; II, 1393
Newtown Creek, N. Y., improvement of..... I, 99, 1044
Nezpique, Bayou, La., improvement of..... I, 246; III, 1828
Niagara, Fort, N. Y., protection of site of ..... I, 11, 625
Niagara River, N. Y.:
Discharge of ..... I, 484; VI, 4364
Improvement of, between Tonawanda and Port Day ..... I, 407; IV, 3113
Improvement of Tonawanda Harbor and..... I, 407; IV, 3111
Survey of shoal at mouth of ..... I, 484; VI, 4378
Nomini Creek, Va., improvement of ..... I, 153; II, 1292
Nooksack River, Wash.:
Construction of bridge at Ferndale across ..... I, 468
Examination of..... I, 446; IV, 3468
Norfolk Harbor, Va.:
Improvement of, and approaches ..... I, 159; II, 1323
Improvement of approach to, between Lambert Point and Fort Norfolk ..... I, 160; II, 1328
Improvement of waterway between Albemarle Sound, N. C., and... I, 164; II, 1341
Norfolk, Va., improvement of approach to navy-yard at, between Lambert Point and Fort Norfolk ..... I, 160; II, 1328
North Galveston, Houston and Kansas City Railroad Company, bridge of ..... I, 466
North Hero Harbor, Vt., examination of..... I, 419; IV, 3213
North Landing River, Va. and N. C., improvement of ..... I, 165; II, 1343
North Menomonee Canal, Milwaukee, Wis., construction of bridge across ..... I, 470
North Muskegon, Mich., construction of bridge across Muskegon Lake by city of ..... I, 468
Northeast Cape Fear River, N. C., improvement of ..... I, 177; II, 1403
Northeast River, Md., improvement of ..... I, 135; II, 1206
Northern and Northwestern Lakes:
See also Great Lakes.
Charts, correcting, printing, and issuing of..... I, 481; VI, 4343
Estimates ..... I, 486
Improvement of ship channels between Chicago, Duluth, and Buffalo ..... I, 389; IV, 2962
Investigation of raft towing on..... I, 394
Surveys ..... I, 481; VI, 4343
Water levels ..... I, 486; VI, 4381
Norwalk Harbor, Conn.:
Examination of ..... I, 91, 991
Improvement of ..... I, 82, 948
Noxubee River, Miss., improvement of..... I, 232; II, 1763

O.

Oak Orchard Harbor, N. Y., improvement of..... I, 408; IV, 3117
Oakland Harbor, Cal., improvement of ..... I, 419; IV, 3217
Obion River, Tenn., improvement of..... I, 298; III, 2327
Obstructions to navigation, action upon bridges constituting..... I, 20, 473
Occidental Bridge and Construction Company, bridge of ..... I, 465
Occoquan Creek, Va., improvement of..... I, 150; II, 1281
Occupancy of structures built by United States ..... I, 20, 475; VI, 4267
Ocklawaha River, Fla., improvement of..... I, 202; II, 1651
Ocmulgee River, Ga., improvement of ..... I, 195; II, 1572
Oconee River, Ga., improvement of ..... I, 194; II, 1567
Oconto Harbor, Wis.:
Establishment of harbor lines in..... I, 462; IV, 2784
Improvement of..... I, 346; IV, 2708
Ocosta, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3481
Ocqueoc River, Mich., examination of Hammond Bay, at mouth of... I, 388; IV, 2948
Ocracoke Inlet, N. C., improvement of..... I, 169; II, 1359

Office of the Chief of Engineers ..... I, 490
Officers of Corps of Engineers, statement of rank and duties of ..... I, 491
Ogdensburg Harbor, N. Y.:
Improvement of ..... I, 415; IV, 3190
Water gauge at ..... I, 486; VI, 4384
Ogeechee River, Ga., construction of bridge across ..... I, 468
Ohio River:
Bridge across, at Cincinnati, reconstruction of ..... I, 464
Dam near mouth of Beaver River, Pa., construction of ..... I, 313; III, 2484
Dam No. 2, survey for location of ..... I, 313; III, 2486
Davis Island Dam, Pa., operating and care of ..... I, 312; III, 2481
Examination for ice harbors at Cincinnati ..... I, 320
Examination for location of locks and dams between Davis Island and Beaver River dams ..... I, 319; III, 2533
Examination of, at Elizabethtown, Ill ..... I, 318; III, 2518
Examination of, at Evansville, Ind ..... I, 318; III, 2520
Examination of bar at mouth of Big Sandy River ..... I, 336; III, 2647
Examination of, between Ironton, Ohio, and 3 miles above mouth of Guyan River, W. Va ..... I, 318; III, 2527
Examination of, between Livingston Point and Tennessee Island, near Paducah, Ky ..... I, 307; III, 2404
Examination of, near Cincinnati, Ludlow, and Covington ..... I, 318; III, 2523
Improvement of ..... I, 310; III, 2438
Improvement of Falls of, Louisville, Ky ..... I, 320; III, 2543
Improvement of Indiana Chute, Falls of ..... I, 321; III, 2549
Louisville and Portland Canal, Ky., operating and care of ..... I, 322; III, 2554
Operating snag boat on ..... I, 312; III, 2478
Oklawaha River, Fla., improvement of ..... I, 202; II, 1651
Olcott Harbor, N. Y., improvement of ..... I, 408; IV, 3116
Old Colony Railroad Company, bridge of ..... I, 474
Old Fort Bayou, Miss., examination of channel at mouth of ..... I, 238; II, 1787
Old River Branch of San Joaquin River, Cal., examination of ..... I, 431; IV, 3294
Olympia Harbor, Wash., improvement of ..... I, 443; IV, 3415
Omaha Bridge and Terminal Company, bridge of ..... I, 465
Onancock Harbor, Va., improvement of ..... I, 141; II, 1225
Ontario, Lake:
See also Northern and Northwestern Lakes.
Survey of shoal off mouth of Niagara River ..... I, 484; VI, 4378
Water levels ..... I, 486; VI, 4381, 4382
Ontonagon Harbor, Mich., improvement of ..... I, 340; IV, 2677
Orange County, Tex., construction of bridge across Cow Bayou, by ..... I, 470
Osage River, Mo., improvement of ..... I, 283; III, 2182
Oswego Harbor, N. Y.:
Establishment of harbor lines in ..... I, 462; IV, 3178
Improvement of ..... I, 412; IV, 3152
Otter Creek, Vt., improvement of ..... I, 417; IV, 3198
Ouachita River, Ark. and La.:
Examination of, above Camden, Ark ..... I, 272; III, 2091
Improvement of ..... I, 261; III, 2002
Owls Head Harbor, Me., examination of ..... I, 38, 730

P.

Paducah, Ky.:
Examination of Ohio River between Livingston Point and Tennessee Island ..... I, 307; III, 2404
Improvement of Livingston Point ..... I, 300; III, 2377
Pamlico River, N. C.:
Improvement of ..... I, 171; II, 1380
Removal of wreck near Washington ..... I, 183; II, 1450
Pamunkey River, Va., improvement of ..... I, 157; II, 1308
Parish Creek, Md., examination of mouth of ..... I, 158; II, 1310
Pascagoula River, Miss., improvement of ..... I, 232; II, 1755
Pasquotank River, N. C., improvement of ..... I, 168; II, 1354
Passaic River, N. J.:
Improvement of ..... I, 109, 1108
Injury to dike ..... VI, 4268
Patapsco River, Md.:
Examination of South and Middle Branches of, at Baltimore ..... I, 148; II, 1262
Improvement of ..... I, 144; II, 1243
Improvement of channel to Curtis Bay ..... I, 145; II, 1249
Patchogue River, N. Y., improvement of ..... I, 96, 983

Patuxent River, Md., improvement of ..... I, 154; II, 1294
Pawcatuck River, R. I. and Conn., improvement of ..... I, 67, 845
Pawtucket River, R. I., improvement of ..... I, 60, 828
Pawtuxet Harbor, Providence River, R. I., examination of ..... I, 71, 868
Pearl River, Miss.:
Below Jackson, improvement of ..... I, 235; II, 1774
Between Carthage and Jackson, improvement of ..... I, 235; II, 1777
Between Edinburg and Carthage, improvement of ..... I, 236; II, 1779
Between Edinburg and Lake Burnside, examination of ..... I, 238; II, 1791
Near Jackson, examination for diversion of, through Tan Yard Branch ..... I, 238; II, 1792
Pease Creek, Fla., improvement of ..... I, 206; II, 1663
Pembroke, Me., examination of channel near Hardys Point, below ..... I, 37, 722
Pennamaquan River, Me., examination of channel near Hardys Point below Pembroke ..... I, 37, 722
Pennsylvania Railroad Company, bridges of ..... I, 466, 472
Penobscot River, Me., improvement of ..... I, 25, 682
Pensacola Harbor, Fla.:
Defense of ..... I, 4
Improvement of ..... I, 219; II, 1710
Pensaukee Harbor, Wis., improvement of ..... I, 347; IV, 2710
Pentwater Harbor, Mich., improvement of ..... I, 375; IV, 2894
Pepin, Lake, Mississippi River, examination for additional harbors of refuge on ..... I, 288; III, 2257
Petaluma Creek, Cal., improvement of ..... I, 429; IV, 3276
Petersburg, Va., examination of Appomattox River at ..... I, 166; II, 1345
Petit Jean River, Ark., improvement of ..... I, 275; III, 2110
Petoskey Harbor, Mich., improvement of ..... I, 379; IV, 2910
Philadelphia Belt Line Railroad Company, bridge of ..... I, 466
Philadelphia, Pa.:
Construction of bridge across Frankford Creek ..... I, 466
Defense of ..... I, 8
Improvement of harbor of ..... I, 121; II, 1152
Piers built by United States, occupancy or injury of ..... I, 20, 475; VI, 4267
Pigeon Bayou, La., improvement of ..... I, 243; III, 1818
Pinafore (schooner), removal of wreck of ..... I, 147; II, 1262
Pine Lake, Mich., improvement of entrance to ..... I, 378; IV, 2908
Pine River, Mich., at St. Clair City, examination of ..... I, 388; IV, 2954
Pittsburg, Fort Wayne and Chicago Railroad Company, bridge of ..... I, 472
Pittsburg, Pa.:
Construction of bridge across Monongahela River at ..... I, 465
Construction of Herr Island Dam, Allegheny River ..... I, 316; III, 2501
Operating and care of Davis Island Dam, Ohio River ..... I, 312; III, 2481
Plaquemine Bayou, La.:
Bank protection at mouth of ..... I, 252; III, 1857
Improvement of ..... I, 243; III, 1818
Platte, Department of the, report of engineer officer ..... I, 488; VI, 4403
Plattsburg Harbor, N. Y., improvement of ..... I, 417; IV, 3195
Plymouth Harbor, Mass., improvement of ..... I, 49, 778
Pocomoke River, Md., examination for connecting Synepuxent Bay with ..... 1,143; II, 1234
Point Judith Pond, R. I., improvement of entrance to ..... I, 66, 841
Point Judith, R. I.:
Construction of harbor of refuge at ..... I, 65, 839
Examination of inner harbor at breakwater ..... I, 71, 877
Point Marion, Pa., construction of bridge across Cheat River at ..... I, 466
Pollock Rip Channel, Mass., removal of wrecks in ..... I, 69, 70, 852, 853, 857
Pontchartrain Lake, La., examination for harbor of refuge on ..... I, 251; III, 1842
Pontchatoula River, La., improvement of ..... I, 240; III, 1810
Porcupine Island, Me., construction of breakwater from Mount Desert to ..... I, 23, 676
Port Angeles, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
Port Chester Harbor, N. Y., improvement of ..... I, 84, 960
Port Clinton Harbor, Ohio:
Improvement of ..... I, 396; IV, 3058
Removal of wreck in ..... I, 404; IV, 3093
Port Huron, Mich.:
Establishment of harbor lines in Black River at ..... I, 462; IV, 2958
Improvement of Black River at ..... I, 385; IV, 2938
Port Jefferson Harbor, N. Y., improvement of ..... I, 87, 971

Port Townsend, Wash., establishment of harbor lines at.....I, 463; IV, 3472, 3182
Port Washington Harbor, Wis., improvement of.....I, 353; IV, 2738
Portage Lake and Lake Superior canals, across Keweenaw Point, Mich.:
Improvement of.....I, 341; IV, 2680
Operating and care of.....I, 342; IV, 2680
Portage Lake, Houghton County, Mich., waterway across Keweenaw Point via:
Improvement of.....I, 341; IV, 2680
Operating and care of.....I, 342; IV, 2680
Portage Lake, Manistee County, Mich.:
Improvement of harbor of refuge at.....I, 377; IV, 2903
Injury to pier at.....VI, 4270
Portage River, Mich., waterway across Keweenaw Point via:
Improvement of.....I, 341; IV, 2680
Operating and care of.....I, 342; IV, 2680
Portland Harbor, Me.:
Defense of.....I, 5
Examination of channel on south side of.....I, 38, 735
Improvement of.....I, 30, 701
Improvement of channel in Back Cove.....I, 31, 705
Portland, Me., alteration of bridge obstructing mouth of Fore River.....I, 472, 474
Potohunk River, N. C., examination of.....I, 183; II, 1451
Potomac River:
Eastern Branch of. *See* Anacostia River.
Great Falls, erection of fishways.....I, 479; VI, 4310
Improvement of, at Washington, D. C.....I, 148; II, 1265
Trespass on Potomac Flats, Washington, D. C.....VI, 4268
Powow River, Mass., improvement of.....I, 40, 745
Presque Isle Peninsula, Erie Harbor, Pa., improvement of.....I, 405; IV, 3101
Primehook Creek, Del., examination of.....I, 143; II, 1231
Providence River, R. I.:
Examination of Pawtuxet Harbor.....I, 71, 868
Improvement of.....I, 61, 830
Removal of Green Jacket Shoal.....I, 62, 832
Provincetown Harbor, Mass., improvement of.....I, 51, 784
Public buildings and grounds, District of Columbia.....I, 480; VI, 4313
Public works of the United States, occupancy or injury of.....I, 20, 475; VI, 4267
Puget Sound and tributary waters, Wash., improvement of.....I, 444; IV, 3425
Pultneyville Harbor, N. Y., improvement of.....I, 410; IV, 3136

Q.

Quinby Creek, S. C., removal of wrecks in.....II, 1530

R.

Raccoon River, Ohio, examination of.....I, 319; III, 2530
Racine Harbor, Wis., improvement of.....I, 355; IV, 2748
Raft towing on Great Lakes, investigation of.....I, 394
Rahway River, N. J., improvement of.....I, 112, 1115
Rancocas River, N. J., improvement of.....I, 126; II, 1174
Rappahannock River, Va., improvement of.....I, 154; II, 1296
Raritan Bay, N. J., improvement of.....I, 104, 1070
Raritan River, N. J., improvement of.....I, 112, 1116
Ravenswood, N. Y., modification of harbor lines at.....I, 461, 1090
Reconnaissances and explorations.....I, 488; VI, 4401
Red Hook Channel, New York Harbor, N. Y., improvement of.....I, 101, 1053
Red River, La. and Ark.:
Improvement of.....I, 258; III, 1901
Improvement of, above Fulton, Ark.....I, 260; III, 1909
Red River of the North, Minn. and N. Dak., improvement of.....I, 293; III, 2282
Redwood Creek, Cal., improvement of.....I, 421; IV, 3225
Regulations and rules and proposed legislation for use of canals.....I, 20
Rescue (sailboat), removal of wreck of.....I, 401; IV, 3093
Reservoirs at headwaters of Mississippi River.....I, 289; III, 2264
River and harbor improvements.....I, 19
Rivers and harbors:
Estimates for.....I, 19
Examinations, surveys, and contingencies of.....I, 459
Roanoke River, N. C.:
Improvement of.....I, 167; II, 1351
Removal of wreck below Edenton.....I, 183; II, 1450

Robbins Reef Light-house, examination for channel west of, to connect mouth of Arthur Kill with New York Harbor ..... I, 105, 1083
Rockland Harbor, Me.:
Examination of ..... I, 37, 729
Improvement of ..... I, 27, 691
Removal of wreck in ..... I, 37, 722
Rogers (schooner), removal of wreck of ..... I, 70, 859
Rogue River, Oregon, from Grants Pass to the mouth, examination of .. I, 445; IV, 3433
Rokes, Nellie V. (schooner), removal of wreck of ..... I, 70, 859
Rondout Harbor, N. Y., improvement of ..... I, 94, 1021
Rouge River, Mich.:
Construction of bridge near Detroit across ..... I, 468
Construction of turning basin in ..... I, 388; IV, 2947
Improvement of ..... I, 387; IV, 2946
Rough River, Ky., improvement of ..... I, 330; III, 2616
Rouse Point, N. Y., construction of breakwater at ..... I, 416; IV, 3192
Rules and regulations and proposed legislation for use of canals ..... I, 20
Rumsey, Ky., reconstruction of lock on Green River at ..... I, 329; III, 2606

S.

Sabine Lake, examination of channel through, from Sabine Pass to mouths of Sabine and Neches rivers, Tex ..... I, 251; III, 1850
Sabine Pass, Tex., improvement of harbor at ..... I, 248; III, 1832
Sabine River, La. and Tex.:
Examination of, from Suddnths Bluff to Logansport ..... I, 251; III, 1848
Improvement of ..... I, 249; III, 1835
Sacketts Harbor, N. Y., improvement of harbor at ..... I, 414; IV, 3166
Saco River, Me., improvement of ..... I, 32, 708
Sacramento River, Cal.:
Construction of bridge at Butte City across ..... I, 467
Improvement of ..... I, 428; IV, 3271
Improvement of, and tributaries ..... I, 460
Saginaw River, Mich., improvement of ..... I, 382; IV, 2924
Saint Augustine Harbor, Fla., improvement of ..... I, 203; II, 1653
Saint Charles, Mo., construction of bridge across Missouri River at ..... I, 465
Saint Clair City, Mich., examination of Pine River at ..... I, 388; IV, 2954
Saint Clair Flats Canal, Mich.:
Improvement of ..... I, 392; IV, 3029
Injury to piers ..... VI, 4272
Occupancy of public land ..... VI, 4271
Operating and care of ..... I, 393; IV, 3031
Saint Croix River, Me., improvement of ..... I, 21, 670
Saint Croix River, Wis. and Minn.:
Improvement of ..... I, 291; III, 2275
Reservoirs at sources of, surveys for ..... III, 2288
Saint Francis River, Ark. and Mo.:
Improvement of, Ark ..... I, 278; III, 2118
Improvement of, Mo ..... I, 278; III, 2119
Saint Johns River, Fla.:
Bridge at foot of Lake Monroe, across, reconstruction of ..... I, 469
Improvement of ..... I, 199; II, 1613
Improvement of upper ..... I, 200; II, 1646
Saint Jones River, Del., examination of mouth of ..... I, 143; II, 1229
Saint Joseph Harbor, Mich.:
Improvement of ..... I, 368; IV, 2864
Use of wing dam by Cincinnati, Wabash and Michigan Railroad Company ..... VI, 4270
Saint Joseph River, Mich.:
Alteration of bridge across ..... I, 471
Improvement of ..... I, 369; IV, 2870
Saint Lawrence River, N. Y.:
Improvement of shoals between Sister Islands and Cross-over Light .. I, 415; IV, 3188
Surveys in ..... I, 485
Water gauge at Ogdensburg ..... I, 486; VI, 4384
Saint Louis Bay, Wis., improvement of harbor at ..... I, 338; IV, 2668
Saint Louis Harbor, Mo., improvement of ..... I, 282; III, 2177
Saint Lucie River, Fla., construction of bridge across ..... I, 471
Saint Marys Falls Canal, Mich.:
Occupancy of public lands, etc ..... VI, 4271
Operating and care of ..... I, 390; IV, 2970

Saint Marys River, Ga. and Fla., construction of bridge across.... .....I, 464
Saint Marys River, Mich:
Establishment of harbor lines at Sault Ste. Marie..... .....I, 462; IV, 3037
Improvement of, at the falls..... .....I, 390; IV, 2991
Improvement of Hay Lake Channel.....I, 391; IV, 3024
Resurvey of, between White Fish Bay and Detour light-house....I, 484; VI, 4344
Saint Paul, Minneapolis and Manitoba Railway Company, bridge of.....I, 464
Saint Paul, Minn., gauging Mississippi River at or near.....I, 294; III, 2289
Sakonnet River, R. I., alteration of bridge at Tiverton obstructing.....I, 474
Salem Harbor, Mass., improvement of..... I, 43, 756
Salem River, N. J., improvement of.....I, 127; II, 1178
Saline River, Ark., examination of.....I, 279; III, 2122
Salkahatchie River, S. C., improvement of.....I, 189; II, 1522
Salt Pond, Block Island, R. I., examination of breachway into.....I, 71, 880
Salt River, near West Point, Ky., construction of bridge across.....I, 469
San Antonio and Aransas Pass Railroad Company, bridge of.....I, 473
San Diego Harbor, Cal., improvement of.....I, 424; IV, 3231
San Francisco Bay, Cal.:
Examination of entrance to (Golden Gate).....I, 420; IV, 3221
Examination of navigable slough known as Twelve-Mile Creek in..I, 425; IV, 3235
San Francisco Harbor, Cal., defense of.....I, 5, 9, 619, 623
San Joaquin County, Cal.:
Construction of bridge across San Joaquin River by.....I, 467
Construction of bridge across South Fork of Mokelumne River by.....I, 469
San Joaquin River, Cal.:
Construction of bridge at Garwood Ferry crossing.....I, 467
Construction of bridge near Grayson, across.....I, 466
Examination of, between Hills Ferry and Firebaughs Ferry, and sloughs above Stockton.....I, 431; IV, 3290
Examination of Old River Branch of.....I, 431; IV, 3294
Improvement of.....I, 426; IV, 3265
Improvement of, and tributaries.....I, 460
San Luis Obispo Harbor, Cal., improvement of.....I, 422; IV, 3226
San Pedro Bay, Cal., examination for deep-water harbor at.....I, 425; IV, 3238
Sand Beach, Lake Huron, Mich., improvement of harbor of refuge at..I, 384; IV, 2931
Sandusky Bay, Ohio, construction of bridge across .....I, 466
Sandusky Harbor, Ohio, improvement of.....I, 397; IV, 3061
Sandusky River, Ohio, improvement of .....I, 398; IV, 3065
Sandy Bay, Cape Ann, Mass., improvement of harbor of refuge at.....I, 41, 748
Santa Monica Bay, Cal., examination for deep-water harbor at .....I, 425; IV, 3238
Santa Rosa Sound, Fla., examination of bar at junction of Choctawhatchee Bay and.....I, 228; II, 1741
Santee River, S. C.:
Bridge about 17 miles below mouth of Congaree River, construction of.....I, 470
Improvement of.....I, 186; II, 1483
Sarasota Bay, Fla., improvement of.....I, 207; II, 1665
Satilla River, Ga., construction of bridge across.....I, 468
Saugatuck Harbor, Mich., improvement of.....I, 370; IV, 2874
Saugatuck River, Conn., improvement of.....I, 81, 945
Saugerties Harbor, N. Y., improvement of.....I, 93, 1019
Saugus River, Mass., examination of .....I, 52, 789
Sault Ste. Marie, Mich., establishment of harbor lines at.....I, 462; IV, 3037
Savannah Harbor, Ga.:
Establishment of harbor lines near quarantine station.....I, 462; II, 1610
Improvement of .....I, 190; II, 1536
Improvement of inside waterway between Fernandina, Fla., and..I, 198; II, 1604
Removal of wreck in.....I, 198; II, 1608
Savannah River, Ga.:
Defense of entrance of .....I, 4
Establishment of harbor lines in, near quarantine station at Savannah .....I, 462; II, 1610
Examination of, between Spirit Island and crossing of Charleston and Savannah Railway.....I, 198; II, 1609
Improvement of, above Augusta.....I, 192; II, 1554
Improvement of, between Augusta and Savannah .....I, 191; II, 1547
Sayville, N. Y., improvement of Browns Creek .....I, 91, 986
School, United States Engineer.....I, 18, 649
Schuylkill River, Pa.:
Improvement of.....I, 122; II, 1164
Removal of wreck in .....II, 1183

Scituate Harbor, Mass., improvement of ..... I, 48, 776
Seaconnet River, R. I., alteration of bridge at Tiverton obstructing ..... I, 474
Seaford Creek, Long Island, N. Y., examination of ..... I, 118, 1134
Seattle, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
Sebewaing River, Mich., examination of ..... I, 388; IV, 2950
Seneca Shoal, Lake Erie, survey of ..... I, 484
Sequatchie River, Tenn., examination of ..... I, 307; III, 2408
Shaws Cove, Conn., establishment of harbor lines in ..... I, 461, 997
Sheboygan Harbor, Wis., improvement of ..... I, 352; IV, 2733
Sheepshead Bay, N. Y., improvement of ..... I, 107, 1103
Shelton, Wash., establishment of harbor lines at ..... I, 463; IV, 3475, 3484
Ship Island Harbor, Miss., examination of ..... I, 237; II, 1783
Shoal Harbor, N. J., improvement of ..... I, 116, 1128
Shovelful Shoal, Mass., removal of wreck at ..... I, 70, 859
Shreveport, La., survey of lakes between Jefferson, Tex., and ..... I, 271; III, 2065
Shrewsbury River, N. J., improvement of ..... I, 117, 1130
Sidney, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3483
Sinepuxent Bay, Md., examination for connecting Pocomoke River with ..... I, 143; II, 1234
Sister Islands, St. Lawrence River, N. Y., improvement of shoals near ..... I, 415; IV, 3188
Sites for fortifications, acquisition of ..... I, 10
Siuslaw River, Oregon, improvement of mouth of ..... I, 435; IV, 3344
Slaughter Creek, Del., examination of ..... I, 143; II, 1231
Smyrna River, Del., improvement of ..... I, 131; II, 1198
Snake River, Wash. and Idaho:
Improvement of, between Huntington Bridge and Seven Devils mining district ..... I, 438; IV, 3372
Improvement of, up to Asotin, Wash ..... I, 438; IV, 3375
Snohomish City, Wash., establishment of harbor lines at ..... I, 463; IV, 3475
Snohomish River, Wash.:
Examination of Everett Harbor and mouth of ..... I, 446; IV, 3464
Examination of, from mouth to Lowell ..... I, 446; IV, 3462
Sooloo (coal barge), removal of wreck of ..... I, 69, 852
South Bend, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
South Haven Harbor, Mich., improvement of ..... I, 370; IV, 2870
South Pass, Mississippi River, inspection of improvement of ..... I, 20, 238; III, 1795
South River, N. J.:
Improvement of ..... I, 113, 1120
Occupancy of dikes ..... VI, 4267
Southern Bridge and Railway Company, bridge of ..... I, 465
Southold Harbor, Long Island, N. Y., examination of ..... I, 92, 996
Spokane River, Idaho, from Post Falls to Lake Cœur d' Alene, examination of ..... I, 446; IV, 3458
Squan River. *See* Manasquan River.
Stamford Harbor, Conn., improvement of ..... I, 83, 954
Stanislaus County, Cal., construction of bridge across San Joaquin River by ..... I, 466
Stanislaus River, Cal., examination of ..... I, 431; IV, 3301
Starlight (tug), removal of wreck of ..... I, 128; II, 1182
State Line Railroad Company, bridge of ..... I, 466
Staten Island and New Jersey, improvement of channel between ..... I, 108, 1106
Staunton River, Va., improvement of ..... I, 166; II, 1350
Steele Bayou, Miss., improvement of ..... I, 267; III, 2045
Steilacoom, Wash., establishment of harbor lines at ..... I, 463; IV, 3472, 3483
Stockbridge Harbor, Wis., examination of ..... I, 359; IV, 2782
Stonington, Conn., improvement of harbor of refuge at ..... I, 68, 847
Stonington Harbor, Conn., examination of ..... I, 71, 891
Storm King (coal barge), removal of wreck of ..... I, 69, 853
Stratford, Conn., alteration of bridge obstructing Housatonic River at ..... I, 474
Structures built by United States, occupancy or injury of ..... I, 20, 475; VI, 4267
Sturgeon Bay and Lake Michigan Canal, Wis.:
Construction of harbor of refuge at eastern entrance of ..... I, 349; IV, 2719
Improvement of ..... I, 348; IV, 2714
Operating and care of ..... I, 349; IV, 2718
Submarine mines ..... I, 10
Sullivans Island, S. C., construction of bridge across cove at ..... I, 469
Sulphur River, Tex., examination of ..... I, 271; III, 2083
Sumpawanus Inlet, N. Y., improvement of ..... I, 106; 1100
Superior Bay, Wis., improvement of harbor at ..... I, 338; IV, 2668

Superior, Lake:
See also Northern and Northwestern Lakes.
Water levels ..... IV, 2995; VI, 4381
Superior, Lake, waterway across Keweenaw Point from Keweenaw Bay to, via Portage Lake and River, Mich:
Improvement of ..... I, 341; IV, 2680
Operating and care of ..... I, 342; IV, 2680
Superior, Wis.:
Establishment of harbor lines in Allouez Bay, near ..... I, 462; IV, 2695
Examination of Allouez Bay and Nemadji River at ..... I, 344; IV, 2692
Improvement of Minnesota Point at ..... I, 339; IV, 2673
Supervision of New York Harbor ..... I, 459; IV, 3541
Surveys, examinations, and contingencies of rivers and harbors ..... I, 459
Susquehanna River above and below Havre de Grace, Md., improvement of ..... I, 134; II, 1205
Suwanee River, Fla., improvement of ..... I, 210; II, 1677
Swansboro, N. C., improvement of waterway between New River and .. I, 176; II, 1399
Swinomish Slough, Wash., improvement of ..... I, 443; IV, 3419
Synepuxent Bay, Md., examination for connecting Pocomoke River with ..... I, 143; II, 1234

T.

Tacoma, Wash., establishment of harbor lines at ..... I, 463; IV, 3472
Tallahatchee River, Miss., improvement of ..... I, 266; III, 2041
Tallapoosa River, Ala., improvement of ..... I, 223; II, 1723
Tampa Bay, Fla., improvement of ..... I, 208; II, 1670
Tan Yard Branch, near Jackson, Miss., examination for diversion of Pearl River through ..... I, 238; II, 1792
Tar River, N. C., improvement of ..... I, 171; II, 1380
Tarbell, G. S. (schooner), removal of wreck of ..... I, 69, 853
Tarentum Bridge Company, bridge of ..... I, 470
Tarentum, Pa., examination for lock and dam on Allegheny River at .. I, 319; III, 2538
Tarpaulin Cove, Naushon Island, Mass., examination for breakwater at ..... I, 71, 864
Taunton River, Mass., improvement of ..... I, 59, 822
Tchefuncte River. *See* Chefuncte River.
Tchula Lake, Miss., improvement of ..... I, 266; III, 2038
Teche, Bayou, La.:
Construction of canal between Grand Lake at Charenton and ..... I, 245
Improvement of ..... I, 245; III, 1824
Removal of wrecks in ..... I, 250; III, 1839
Tennant Harbor, Me., examination of ..... I, 38, 732
Tennessee Island, examination of Ohio River between Livingston Point, Ky., and ..... I, 307; III, 2404
Tennessee River:
Bridge across, at Knoxville, Tenn., construction of ..... I, 463
Bridge at Johnsonville, Tenn., alteration of ..... I, 472
Improvement of ..... I, 298; III, 2330
Improvement of, above Chattanooga, Tenn ..... I, 298; III, 2330
Improvement of, below Bee Tree Shoals, Ala ..... I, 300; III, 2375
Improvement of, below Chattanooga, Tenn ..... I, 310; III, 2430
Improvement of, between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala ..... I, 308; III, 2419
Muscle Shoals Canal, operating and care of ..... I, 310; III, 2431
Survey of, between Chattanooga and junction of Holston and French Broad rivers, Tenn ..... I, 299; III, 2333
Tensas River, La., improvement of ..... I, 263; III, 2018
Terrebonne, Bayou, La.:
Examination for connecting Bayou Black with ..... I, 251; III, 1845
Improvement of ..... I, 243; III, 1817
Thames River, Conn., improvement of ..... I, 72, 901
Three Mile Creek, Ala., alteration of bridge across ..... I, 473
Three Mile Rapids, Columbia River, examination for overcoming obstructions at ..... I, 458
Thunder Bay Harbor, Mich., improvement of ..... I, 381; IV, 2920
Thunder Bay River, Mich., improvement of ..... I, 381; IV, 2922
Tickfaw River, La., and its tributaries, improvement of ..... I, 240; III, 1813
Ticonderoga River, N. Y., improvement of ..... I, 418; IV, 3200
Tillamook Bay and Bar, Oregon, improvement of ..... I, 437; IV, 3368
Tiverton, R. I., alteration of bridge obstructing Sakonnet River at ..... I, 473

Tobias Landing, Vt., examination of harbor at ..... I, 419; IV, 3215
Toledo Harbor, Ohio, improvement of ..... I, 395; IV, 3050
Tombigbee River, Miss. and Ala., improvement of ..... I, 230; II, 1755
Below Demopolis ..... I, 230; II, 1788
Between Demopolis and Columbus ..... I, 231; II, 1759
Between Fulton and Columbus ..... I, 231; II, 1760
Between Walkers Bridge and Fulton ..... I, 232; II, 1762
Tonawanda Harbor, N. Y., improvement of ..... I, 407; IV, 3111
Tradewater River, Ky., improvement of ..... I, 329; III, 2606
Trent River, N. C., improvement of ..... I, 172; II, 1387
Trinity River, Tex., improvement of ..... I, 255; III, 1880
Tug Fork of Big Sandy River, W. Va. and Ky., improvement of ..... I, 333; III, 2637
Tuolumne River, Cal., examination of ..... I, 431; IV, 3299
Twelve Mile Creek, San Francisco Bay, Cal., examination of ..... I, 425; IV, 3235
Two Rivers Harbor, Wis., improvement of ..... I, 351; IV, 2727
Tybee Roads, Ga., defense of ..... I, 4

U.

Umpqua River, Oregon, improvement of ..... I, 435; IV, 3342
Undine (bark), removal of wreck of ..... I, 198; II, 1608
United States Engineer School ..... I, 18, 649
United States navy-yard, Norfolk, Va., improvement of approach to harbor at ..... I, 160; II, 1328
United States structures, occupancy or injury of ..... I, 20, 475; VI, 4267
Urbana Creek, Va., improvement of ..... I, 155; II, 1301
Use of public works by corporations and individuals ..... I, 20, 475; VI, 4267

V.

Van Buren, Ark., removal of wreck at ..... I, 279; III, 2121
Vancouver, Wash., improvement of Columbia River near ..... I, 449; IV, 3503
Vermilion Harbor, Ohio, improvement of ..... I, 399; IV, 3071
Vermillion Bayou, La., improvement of ..... I, 246; III, 1826
Vinal Haven, Me., examination of ..... I, 37, 725
Vincent Cove, Gloucester Harbor, Mass., examination of ..... I, 52, 788
Vineyard Haven Harbor, Mass., improvement of ..... I, 55, 811
Vineyard Sound Light-ship, Mass., removal of wreck near ..... I, 69, 852
Volusia Bar, Fla., improvement of ..... I, 201; II, 1648

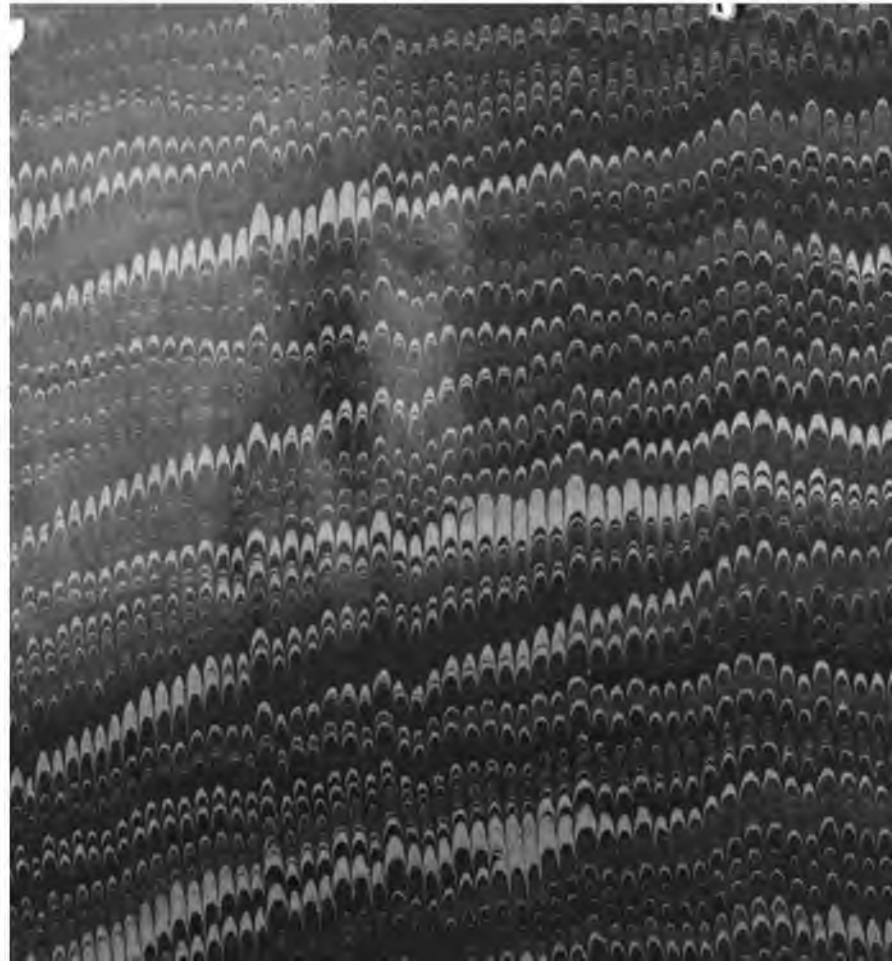
W.

Wabash Railroad Company, bridge of ..... I, 468
Wabash River, Ind. and Ill., improvement of ..... I, 322; III, 2559
Above Vincennes ..... I, 323; III, 2562
Below Vincennes ..... I, 322; III, 2560
Waccamaw River, N. C. and S. C., improvement of ..... I, 184; II, 1464
Wappinger Creek, N. Y., improvement of ..... I, 95, 1024
Wappoo Cut, S. C., improvement of ..... I, 188; II, 1514
Wareham Harbor, Mass., improvement of ..... I, 56, 813
Warrior River, Ala., improvement of ..... I, 230; II, 1755
Warwick River, Md., improvement of ..... I, 138; II, 1216
Washington aqueduct, Washington, D. C ..... I, 475; VI, 4275
Washington Bayou, Miss., improvement of ..... I, 267; III, 2045
Washington, D. C.:
Anacostia River, improvement of ..... I, 148; II, 1265
Defense of ..... I, 5, 8
Increasing water supply ..... I, 478; VI, 4309
Potomac River at, improvement of ..... I, 148; II, 1265
Public buildings and grounds ..... I, 480; VI, 4313
Trespass on Potomac Flats ..... VI, 4268
Washington aqueduct ..... I, 475; VI, 4275
Washington Monument ..... I, 480; VI, 4316
Washington, establishment of harbor lines at ports in State of ..... I, 462; IV, 3472
Washington Monument, Washington, D. C ..... I, 480; VI, 4316
Washington, N. C., removal of wreck near ..... I, 183; II, 1450
Wateree River, S. C., improvement of ..... I, 186; II, 1488
Waterways:
Between Bayous Black and Terrebonne, La., and inland route from Mississippi Valley to Texas and Mexico, examination for ..... I, 251; III, 1845
Between Beaufort Harbor and New River, N. C., improvement of ..... I, 175 II, 1397

Waterways—Continued.
Between Chincoteague Bay, Va., and Delaware Bay, improvement of ..... I, 133; II, 1203
Between Mispillion and Broadkiln rivers, Del., examination of ... I, 143; II, 1231
Between New River and Swansboro, N. C., improvement of ..... I, 176; II, 1399
Between Newbern and Beaufort, N. C., improvement of ..... I, 174; II, 1393
Between Norfolk Harbor, Va., and Albemarle Sound, N. C., improvement of ..... I, 164; II, 1343
Between Pocomoke River and Synepuxent Bay, Md. (between Chesapeake and Delaware bays), examination for ..... I, 143; II, 1234
Between Savannah, Ga., and Fernandina, Fla., improvement of ... I, 198; II, 1604
Cypress Bayou and lakes between Jefferson, Tex., and Shreveport, La., survey of ..... I, 271; III, 2065
From Keweenaw Bay to Lake Superior via Portage Lake and River, Mich., improvement and operation of ..... I, 341, 342; IV, 2680
Waukegan Harbor, Ill., improvement of ..... I, 356; IV, 2754
Wellfleet Harbor, Mass., improvement of ..... I, 51, 782
West Elizabeth Bridge Company, bridge of ..... I, 464
West Farms, N. Y., reconstruction of bridge across Bronx River below ..... I, 469
West Galveston Bay, Tex., improvement of ..... I, 254; III, 1877
West Point, Ky., construction of bridge across Salt River near ..... I, 469
Westport Harbor, Conn., examination of ..... I, 91, 990
Westport Harbor, Mass., improvement of ..... I, 58, 818
Weymouth River, Mass., improvement of ..... I, 47, 773
Whale Creek, N. J., examination of ..... I, 118, 1138
Whatcom County, Wash., construction of bridge across Nooksack River by ..... I, 468
White Lake Harbor, Mich., improvement of ..... I, 374; IV, 2890
White Oak Bayou, Tex., construction of bridge at Houston across ..... I, 466
White River, Ark., improvement of ..... I, 275; III, 2111
White River, Ind., improvement of ..... I, 323; III, 2567
Wickford Harbor, R. I., examination of ..... I, 71, 873
Wicomico River, Md.:
Examination of (western shore of Maryland) ..... I, 158; II, 1312
Improvement of ..... I, 140; II, 1222
Wilcox (tug), removal of wreck of ..... I, 404; IV, 3093
Wild Pigeon (schooner), removal of wreck of ..... I, 105, 1076
Willamette River, Oregon:
Above Oregon City, examination of ..... I, 457; IV, 3529
Above Portland, improvement of ..... I, 455; IV, 3522
Below Portland, improvement of ..... I, 452; IV, 3515
Willapa River and Harbor, Wash., improvement of ..... I, 441; IV, 3402
Willets Point, N. Y., post of ..... I, 17, 647
Wilmington, Columbia and Augusta Railroad Company, bridge of ..... I, 467
Wilmington Harbor, Cal., improvement of ..... I, 423; IV, 3229
Wilmington Harbor, Del., improvement of ..... I, 129; II, 1194
Wilmington, N. C., improvement of Cape Fear River at ..... I, 179; II, 1419
Wilson Harbor, N. Y., improvement of ..... I, 408; IV, 3114
Wilsons Point Harbor, Conn., improvement of ..... I, 82, 950
Wind Point, Wis., removal of wreck off ..... I, 358; IV, 2777
Winnebago, Lake, Wis.:
Examination of Calumet Harbor on ..... I, 359; IV, 2783
Examination of Stockbridge Harbor on ..... I, 359; IV, 2782
Winthrop Harbor, Mass., improvement of ..... I, 45, 761
Winyaw Bay, S. C., improvement of ..... I, 182; II, 1441
Wisconsin River, Wis., surveys for reservoirs at sources of ..... III, 2288
Withlacoochee River, Fla., improvement of ..... I, 209; II, 1674
Wolf Lake, Ind., examination of ..... I, 366; IV, 2850
Wolf River Harbor, Ind., examination of ..... I, 366; IV, 2850
Wolf River, Ind., examination of ..... I, 366; IV, 2850
Wolf River, Miss., examination of bar at mouth of ..... I, 238; II, 1787
Wolf River, Tenn., examination of ..... I, 280; III, 2136
Woodbury, J. B. (schooner), removal of wreck of ..... I, 69, 849
Woods Holl, Mass., examination of ..... I, 70, 860
Wrecks, removal of ..... I, 19
Absecon Inlet, N. J., near ..... I, 128; II, 1182
Albemarle Sound, N. C ..... I, 183; II, 1449
Arkansas River ..... I, 279; III, 2121
Ashley River, S. C ..... I, 189; II, 1531
Atlantic City, N. J., near ..... I, 128; II, 1182
Baltimore Harbor, Md ..... I, 147; II, 1203

Wrecks, removal of—Continued.
Barnegat Inlet, N. J ..... I, 128; II, 1182
Beaufort River, S. C ..... II, 1530
Brigantine Shoal, N. J ..... II, 1183
Bronx River, N. Y ..... I, 105, 1076
Browneys Island, Me., off ..... I, 37, 722
Cape Charles, Va., near ..... I, 166; II, 1344
Cape Fear River, N. C ..... I, 183; II, 1450
Charleston Harbor, S. C ..... I, 189; II, 1531
Chesapeake Bay ..... I, 166; II, 1344
Cooper Creek, N. J ..... II, 1183
Cooper River, S. C ..... I, 189; II, 1530
Delaware Bay, off entrance of ..... I, 128; II, 1183
Delaware River ..... II, 1183
Dutch Island Harbor, Narragansett Bay, R. I ..... I, 69, 851
Edgartown Harbor, Mass ..... I, 70, 857
Fairhaven Harbor, Mass ..... I, 69, 851
Great Egg Harbor Inlet, N. J ..... I, 128; II, 1182
Mispillion River, Del ..... I, 143; II, 1223
Mississippi River ..... I, 280; III, 2139
Mobile River, Ala ..... I, 237; II, 1782
Monomoy, Mass., near ..... I, 69, 70, 849, 850, 854, 855, 859
Nantucket Harbor, Mass ..... I, 70, 856
New York Harbor, N. Y ..... I, 105, 1076
Pamlico River, N. C ..... I, 183; II, 1450
Pollock Rip Channel, Mass ..... I, 69, 70, 852, 853, 857
Port Clinton Harbor, Ohio ..... I, 404; IV, 3093
Quinby Creek, S. C ..... II, 1530
Roanoke River, N. C ..... I, 183; II, 1450
Rockland Harbor, Me ..... I, 37, 722
Savannah Harbor, Ga ..... I, 198; II, 1608
Schuylkill River, Pa ..... II, 1183
Teche, Bayou, La ..... I, 250; III, 1839
Vineyard Sound Light-ship, Mass., near ..... I, 69, 852
Wind Point, Wis., off, Lake Michigan ..... I, 358; IV, 2777

Y.

Yadkin River, N. C., improvement of ..... I, 181; II, 1435
Yamhill River, Oregon:
Examination for lock and dam at Lafayette ..... I, 457; IV, 3531
Improvement of ..... I, 455; IV, 3522
Yaquina Bay, Oregon:
Examination of harbor at ..... I, 432; IV, 3314
Improvement of ..... I, 436; IV, 3357
Yazoo River, Miss.:
Improvement of ..... I, 264; III, 2024
Improvement of mouth of ..... I, 265; III, 2029
Yellow Banks, Wis., improvement of ..... I, 290; III, 2272
Yellowstone National Park, construction and improvement of roads and bridges in ..... I, 486; VI, 4391
Yellowstone River, Mont. and N. Dak., improvement of ..... I, 297; III, 2321
York Harbor, Me., improvement of ..... I, 34, 714
York River, Va., improvement of ..... I, 156; II, 1303
Youghiogheny Central Railway Company, bridge of ..... I, 466
Youghiogheny River, Pa., construction of bridge across ..... I, 468
Youngs Bay at Flavel, Oregon, establishment of harbor lines in ..... I, 463; IV, 3537
Youngs River, Oregon, improvement of ..... I, 456; IV, 3527
Yuma, Ariz., improvement of Colorado and Gila rivers at ..... I, 424; IV, 3234

O